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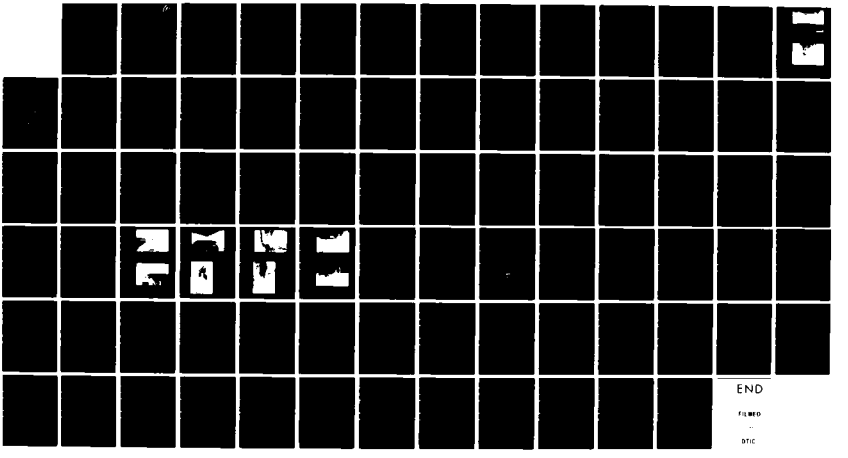

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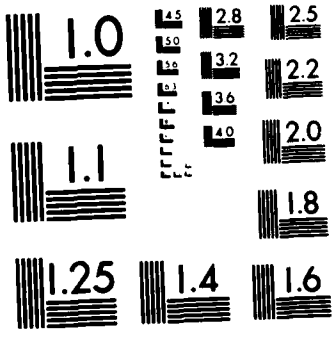
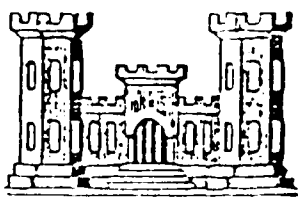


CONNECTICUT RIVER BASIN
LEYDEN , MASSACHUSETTS

LOWER GLEN (GREENFIELD) RESERVOIR DAM
MA 00048

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MARCH 1981

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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4. TITLE (and Subtitle) Lower Glen (Greenfield) Reservoir Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
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9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Connecticut River Basin
Leyden, Massachusetts

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Lower Glen (Greenfield) Reservoir Dam is 46 foot high stone masonry dam. The dam has a crest approximately 95 feet long. The dam appears to be in poor overall condition. It has a maximum storage capacity of approximately 87 acre-feet and a maximum height of about 46 feet. The recommended range for the test flood for an "Intermediate" size, "Significant" hazard dam is from one-half of the PMF to the full PMF.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDED

APR 2 1981

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Lower Glen (Greenfield) Reservoir Dam (MA-00048) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Town of Greenfield, Department of Public Works, Water Division, Court Square, Greenfield, Massachusetts 01301.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

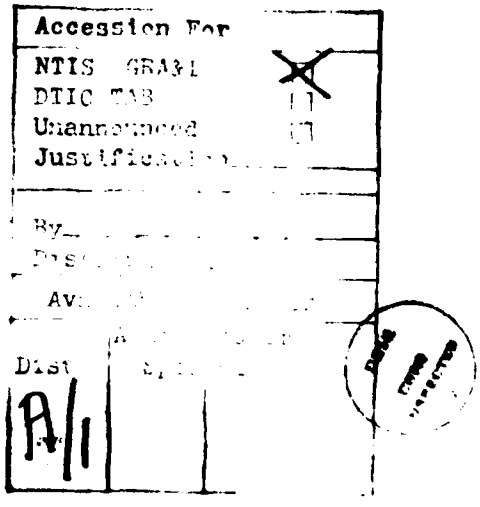
Sincerely,

C.E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

LOWER GLEN (GREENFIELD) RESERVOIR DAM

MA 00048



CONNECTICUT RIVER BASIN

LEYDEN, MASSACHUSETTS

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification Number:	MA 00048
Name of Dam:	Lower Glen (Greenfield) Reservoir Dam
Town:	Leyden
County and State:	Franklin County, Massachusetts
Stream:	Glen Brook
Date of Inspection:	December 3, 1980

BRIEF ASSESSMENT

Lower Glen (Greenfield) Reservoir Dam is a 46-foot high stone masonry dam, spanning the lower portion of a 300-foot deep V-shaped valley. The dam has a crest approximately 95 feet long, a vertical downstream face, a service spillway and an auxiliary spillway. The upstream face of the dam is submerged, and since no construction data are available, the configuration of the upstream side of the dam is unknown. The dam was constructed around 1904 to provide a water supply reservoir for the Town of Greenfield. The reservoir has not been used for water supply purposes for more than 30 years; therefore, the dam now serves no useful purpose.

The dam appears to be in poor overall condition. Several joints have opened due to structural movement of the dam as evidenced by a bulge on the downstream face of the dam located just to the east of the center dam pier at mid-height. A great deal of seepage was observed at the location of the bulge and toward the east side groin area.

Lower Glen (Greenfield) Reservoir has a maximum storage capacity of approximately 87 acre-feet and a maximum height of about 46 feet. According to guidelines established by the Corps of Engineers, the height of the dam places it in the "Intermediate" size category. If Lower Glen (Greenfield) Reservoir Dam were to fail, appreciable property damage, but little or no loss of life, could be expected at the hazard area located approximately 1.6 miles downstream of the dam. Therefore, the hazard classification for the dam is "Significant". The recommended range for the test flood for an "Intermediate" size, "Significant" hazard dam is from one-half of the Probable Maximum Flood (PMF) to the full PMF. The selected test flood for this dam assessment is one-half of the PMF.

The test flood peak inflow to Lower Glen (Greenfield) Resevoir was computed to be 3,760 cfs. The test flood peak overflow is also 3,760 cfs, with a discharge 4.8 feet over the top of the dam. The service and auxiliary spillways have a combined discharge capacity of 740 cfs, or 20 percent of the routed test flood outflow, just prior to overtopping of the dam.

Within one year of receipt of this Phase I inspection report, the Owner, the Town of Greenfield, should retain the services of a qualified, registered professional engineer, experienced in the design and construction of dams for the following purposes: 1) perform detailed structural stability analyses of the dam and recommend measures to be taken to insure its structural integrity; 2) perform detailed hydrologic and hydraulic analyses to assess the need for increasing the project

discharge capacity and to evaluate the ability of the structure to withstand overtopping; 3) investigate the source and nature of the clear spurting seepage observed along the downstream face of the dam; 4) design and direct the installation of a reservoir drawdown system; 5) direct the removal of trees and their root systems from the dam and direct the replacement of affected stone masonry units in the dam.

In addition, the Owner should implement the following operational and maintenance procedures: 1) repair access bridges; 2) institute a program of annual technical inspection of the dam; 3) establish and implement a regular maintenance program for the dam; 4) Develop a formal downstream warning system.

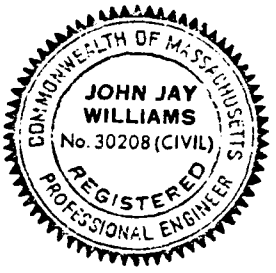
As an alternative to the above recommendations and remedial measures, the lake could be drained and the dam removed.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams

Date: 3 MARCH 81

John J. Williams, P.E.
Vice President
Massachusetts Registration No. 30208



This Phase I Inspection Report on Lower Glen (Greenfield) Reservoir Dam (MA-00048) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Geotechmical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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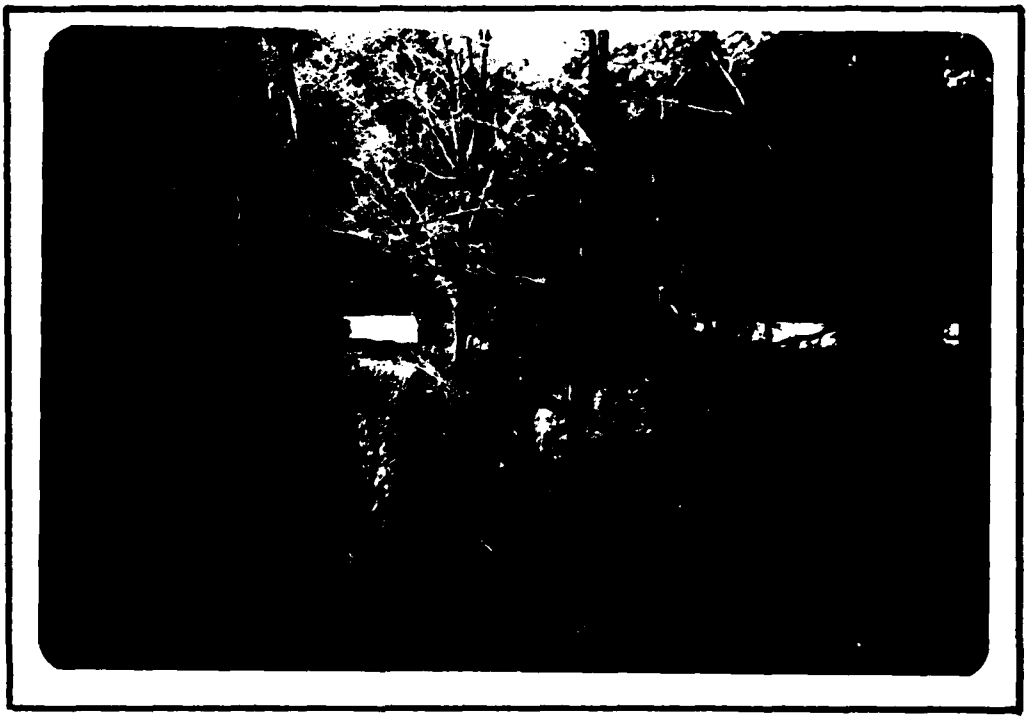
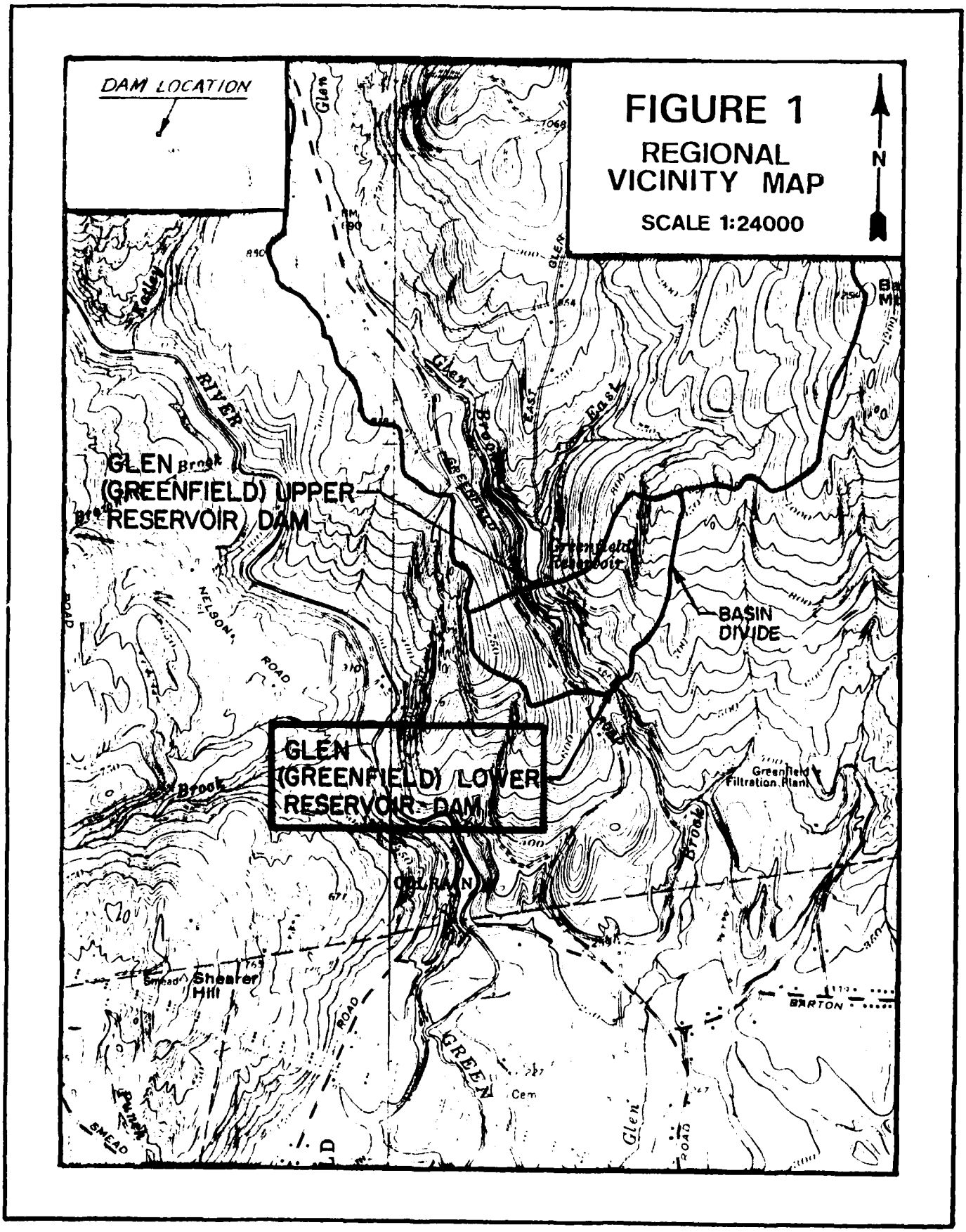
APPENDICES

UPSTREAM OVERVIEW OF THE DAM AND SURROUNDINGS. (12/3/80)



DOWNSTREAM OVERVIEW OF THE DAM. (12/3/80)


DAM LOCATION
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24000
N
GLEN BROOK
(GREENFIELD) UPPER
RESERVOIR DAM
GLEN
(GREENFIELD) LOWER
RESERVOIR DAM
BASIN
DIVIDE
NELSON
ROAD
RIVER
Greenfield
Filtration Plant
Shearer
Hill
BARTON
GREEN
Cem
EMEAD
ROAD

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The National Dam Inspection Act (Public Law 92-367) was passed by Congress on August 8, 1972. Under this Act, the Secretary of the Army was authorized to initiate, through the Corps of Engineers, the National Program for Inspection of Dams throughout the United States. Responsibility for supervising inspection of dams in the New England Region has been assigned to the New England Division of the Army Corps of Engineers.

O'Brien & Gere Engineers, Inc., has been retained by the New England Division to inspect and report on selected non-federal dams in the Commonwealth of Massachusetts. Authorization and Notice to Proceed were issued to O'Brien & Gere Engineers, Inc. by a letter dated November 12, 1980 and signed by Col. William E. Hodgson, Jr. Contract No. DACW33-81-C-0016 has been assigned by the Corps for this work.

b. Purpose. The purpose of inspecting and evaluating non-federal dams is to:

1. Identify conditions which threaten public safety and make the Owner aware of any deficiencies so that he may correct them in a timely manner.

2. Encourage and prepare the Commonwealth to initiate an effective dam safety program for non-federal dams as soon as possible.

3. Update, verify and complete the National Inventory of Dams.

I.2 Description of Project (Information with respect to this dam was obtained from Mr. James Cook, Engineer for the Town of Greenfield.)

a. Location. Lower Glen (Greenfield) Reservoir Dam is located on Glen Brook in the Town of Leyden, Massachusetts. Glen Brook flows from the dam in a southerly direction for approximately 2.5 miles to the Green River. Thence, the Green River flows generally to the south for approximately 5 miles to its point of confluence with the Deerfield River. From that point, the Deerfield River flows easterly for approximately 2 miles to join the Connecticut River. To illustrate the location, portions of the USGS quadrangle map entitled "Colrain, Mass.-Vt." and "Bernardston, Mass.-Vt." have been put together and included as Figure 1 on page vi of this report. USGS reference coordinates for this dam are N42^{o}39.4' and W72^{o}36.7'.

b. Description of Dam and Appurtenances. Lower Glen (Greenfield) Reservoir Dam is a stone masonry dam approximately 95 feet long with a maximum height of about 46 feet. The top of the dam varies from 10 to 14 feet wide and bows slightly at the center (convex upstream). The downstream face is vertical; however,

because the upstream face was submerged and no sectional drawings of the dam could be found, the configuration of the upstream face is unknown. An abandoned pump house is located on the east end of the dam.

Two spillways are located near the center of the dam. The service spillway is 21 feet wide and is located on the west side of the pier in the center of the dam. A 20-foot wide auxiliary spillway is located on the east side of the center dam pier. The respective spillway crests are approximately 4.5 feet and 2.5 feet below the crest of the dam and both are lined with a 6-inch thick concrete cap.

The dam has two outlet valves. One of the valves is located just upstream of the center dam pier, as evidenced by the broken handwheel shown on photo 1 in Appendix C. This valve is believed to be for the low level outlet which is a 24-inch diameter pipe with an outlet invert of about El. 440. The other valve located just to the east of the center dam pier is for the mid-level outlet which is a 3-inch diameter pipe witn an outlet invert of about El. 445.5 . According to the Owner, neither of the valves is operable.

The dam appears to be founded on bedrock. The abutments of the dam consist of vertically bedded outcroppings of schist. The channel downstream from the dam consists primarily of bedrock outcrops and boulders.

c. Size Classification. Lower Glen (Greenfield) Reservoir Dam has a maximum storage capacity of approximately 87 acre-feet and a maximum height of about 46 feet. Because the height is greater than 40 feet, Lower Glen (Greenfield) Reservoir Dam is classified as an "Intermediate" size dam.

d. Hazard Classification. Flow resulting from failure of Lower Glen (Greenfield) Reservoir Dam would be routed via Glen Brook to an agricultural area (flood plain) located approximately one mile downstream of the dam. Based upon computer analysis of a hypothetical breach of the dam, flooding to a depth of approximately 0.5 feet would occur at one residence on a farm at the damage center located approximately 1.6 miles downstream of the dam (Refer to Page B-3). Because it is likely that appreciable property damage would result, but little or no chance for loss of life is anticipated, Lower Glen (Greenfield) Reservoir Dam is classified as a "Significant" hazard structure.

e. Ownership. The dam is owned by the Town of Greenfield, Department of Public Works, Water Division; Town Offices - Court Square, Greenfield, Massachusetts 01301. Telephone: (413) 772-0166.

f. Operator. Dams owned by the Town of Greenfield are operated through the Department of Public Works - Water Division. For practical purposes, however, there is no operator since Lower Glen (Greenfield) Reservoir is abandoned.

g. Purpose of the Dam. The dam was originally constructed for water supply purposes, but was abandoned over 30 years ago. Currently, the dam serves no purpose.

h. Design and Construction History. Lower Glen (Greenfield) Reservoir Dam was originally constructed in 1904 to impound water for water supply purposes. Upper Glen (Greenfield) Reservoir Dam was constructed in 1912 to provide a gravity-feed water supply source, thereby eliminating the need for pumping water from Lower Glen (Greenfield) Reservoir. Further information relative to Lower Glen (Greenfield) Reservoir is not available.

i. Normal Operating Procedures. There are no operating procedures performed on a routine basis. For practical purposes, the dam is abandoned.

1.3 Pertinent Data

a. Drainage Area. The watershed for Lower Glen (Greenfield) Reservoir Dam consists of a total of 5.4 square miles of primarily steep and wooded terrain. Of that total, 5.2 square miles drain to Upper Glen (Greenfield) Reservoir Dam.

b. Discharge at Damsite.

1. Outlet Works. Two outlets are located in the dam, neither of which is operable. (See Section 1.2.b.). The mid-level outlet is a 3-inch diameter pipe and the low-level outlet is a 24-inch diameter pipe. The inverts of the outlets are approximately El. 445.5 and El. 440.

2. Maximum Known Flood at Damsite. Unknown

3. Ungated Spillway Capacity at Top of Dam. The combined spillway capacity of the service and auxiliary spillways with the reservoir surface at the top of the dam is 740 cfs.

4. Ungated Spillway Capacity at Test Flood Elevation. The combined spillway capacity with the reservoir surface at test flood elevation 475.3 is about 2,000 cfs.

5. Gated Spillway Capacity at Normal Pool. Not applicable.

6. Gated Spillway at Test Flood Elevation. Not applicable.

7. Total Spillway Capacity at Test Flood Elevation. The combined spillway capacity with the reservoir surfaces at test flood elevation 475.3 is about 2,000cfs.

8. Total Project Discharges at Top of Dam. The combined spillway capacity of the service and auxiliary spillways with the reservoir surfaces at the top of the dam is 740 cfs.

9. Total Project Discharge at Test Flood Elevation. The combined discharge capacity of the spillways and the flow over the dam at Test Flood Elevation 475.3 is 3,760 cfs.

c. Elevation. (NGVD)

1.	Streambed at Toe of Dam	424.5
2.	Bottom of Cutoff	Unknown
3.	Maximum Tailwater	Unknown
4.	Normal Pool	466.0
5.	Full Flood Control Pool	NA
6.	Service Spillway Crest	466.0
7.	Auxiliary Spillway Crest	468.0
8.	Design Surcharge (Original Design)	NA
9.	Top of Dam	470.5
10.	Test Flood Design Surcharge	475.3

d. Reservoir Length. (Feet)

1. Normal Pool	1,200
2. Flood Control Pool	NA
3. Service Spillway Crest Pool	1,200
4. Auxiliary Spillway Crest Pool	1,400
5. Top of Dam Pool	1,700
6. Test Flood Pool	1,800

e. Storage. (Acre-Feet)

1. Normal Pool	64
2. Flood Control Pool	NA
3. Service Spillway Crest Pool	64
4. Auxiliary Spillway Crest Pool	74
5. Top of Dam Pool	87
6. Test Flood Pool	114

f. Reservoir Surface Area. (Acres)

1. Normal Pool	4.8
2. Flood Control Pool	NA
3. Service Spillway Crest Pool	4.8
4. Auxiliary Spillway Crest Pool	4.9
5. Top of Dam Pool	5.1
6. Test Flood Pool	5.7

g. Dam Data.

1. Type	Stone Masonry
2. Length	95 feet
3. Height	46 feet
4. Top Width	Varies to 14 feet
5. Side Slopes (Upstream)	Unknown
(Downstream)	Vertical
6. Zoning	Unknown
7. Impervious Core	Unknown
8. Cutoff	Unknown
9. Grout Curtain	Unknown

h. Diversion and Regulating Tunnel. Not applicable.

i. Spillways.

1. Service Spillway

a.) Type	Broad Crested Concrete Weir
b). Length of Weir	21 feet
c.) Crest Elevation	466.0
d.) Gates	None
e.) Upstream Channel	Glen Brook
f.) Downstream Channel	Glen Brook

2. Auxiliary Spillway

a.) Type	Broad Crested Concrete Weir
b.) Length of Weir	20 feet
c.) Crest Elevation	468.0
d.) Gates	None
e.) Upstream Channel	Glen Brook
f.) Downstream Channel	Glen Brook

j. Regulating Outlets.

1. Low Level Outlet

a.) Invert Elevation, Inlet	Unknown
b.) Invert Elevation, Outlet	±440
c.) Size	24-inch diameter
d.) Description	Circular Pipe
e.) Control Mechanism	Sluice Gate (Inoperable)

2. Mid-Level Outlet

a.) Invert Elevation, Outlet	Unknown
b.) Invert Elevation, Outlet	±445.5
c.) Size	3-inch diameter
d.) Description	Circular Pipe
e.) Control Mechanism	Valve (Inoperable)

SECTION 2

ENGINEERING DATA

2.1 Design

According to Mr. James Cook, Engineer for the Town of Greenfield, no information with respect to the design of Lower Glen (Greenfield) Reservoir Dam is available.

2.2 Construction

Similarly, no construction information could be found.

2.3 Operation

Since Lower Glen (Greenfied) Reservoir Dam is abandoned, no operating records are currently kept. Apparently, no past records of operation are available.

2.4 Elevation

a. Availability. Very little information could be found. One drawing of the dam was obtained from the Town of Greenfield Department of Public Works - Water Division.

b. Adequacy. The drawing, along with information obtained during visual inspection of the dam, proved adequate for a Phase I evaluation.

c. Validity. The drawing appears to be in general conformance with the field measurements.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. Lower Glen (Greenfield) Reservoir Dam was inspected on December 3, 1980. At the time of inspection, the reservoir pool was slightly above the spillway crest Elevation 466 shown on the USGS map. No underwater areas were inspected.

The observations and comments of the field inspection team are noted on a checklist included as Appendix A of this report.

b. Dam. The dam is located in a narrow valley with very steep outcroppings of vertically bedded schist forming the valley walls. The abutment areas, on both the upstream and downstream sides of the dam, are over grown with coniferous trees. Downstream of the dam, the brook follows a well-defined and boulder strewn weathered rock channel.

The dam is in a state of disrepair. No safe access across the dam is available because the walkway on the access bridge is missing. The center pier and side stone masonry abutments have joint openings averaging about 0.5 inches, where mortar has been presumably broken away. The downstream face of the dam has many open joints between various size stone blocks and shows evidence of structural movement toward the mid-height of the dam just to the east of the center dam pier. In addition, the concrete caps on both the service and auxiliary spillways are cracked at their adjacent abutments and one 6-inch diameter tree was observed growing out of the center pier of the dam.

A great deal of clear seepage (5 cfs) was observed spurting from between the joints at the downstream face of the dam. The major portion of the seepage was occurring between a "bulge" in the downstream dam face located just to the east of the the center dam pier and the east side groin area. A photo of this condition, along with other photos of the dam, are included in Appendix C.

c. Appurtenant Structures. An abandoned pump house is located on the east side of the dam. Construction is of concrete masonry blocks and it is in poor condition with no doors. Some pumping equipment which has been inoperable for many years is inside. Two electrical conduits which span the access bridge railing to the structure appear to have been taken out of service.

The access bridge over the dam and the service bridge to the low level outlet operator are also in very poor condition. The bridges lack any decking necessary for safe access across and operation of the dam. As shown on photo 1 in Appendix C, only the railings remain on the access bridge over the dam.

According to Mr. James Cook, Engineer for the Town of Greenfield, neither the low level outlet sluice gate nor the mid-level outlet valve are operable. The hand wheel operator for the low level outlet sluice gate is broken (photo 1, Appendix C) and the valve for the mid level outlet located at the downstream toe of the dam has not been operated for more than 30 years.

A 30-inch diameter water supply main, from Upper Glen (Greenfield) Reservoir, bypasses Lower Glen (Greenfield) Reservoir on its eastern bank (photo 6). The line has several tapped connections which may be used to introduce water under pressure to flush the line. A blind flange, located at a tee connection just downstream of Lower Glen (Greenfield) Reservoir Dam, may be used for draining the line.

d. Reservoir Area. The entire perimeter of Lower Glen (Greenfield) Reservoir consists of generally steep (up to 100 percent) slopes and forested terrain. Indications of reservoir slope instability or excessive siltation of the reservoir were not apparent at the time of the inspection.

e. Downstream Channel. Downstream of Lower Glen (Greenfield) Reservoir Dam, Glen Brook follows a steep, well-defined channel through weathered bedrock and loose boulders. Many coniferous trees overhang the channel, but do not significantly obstruct flow.

3.2 Evaluation

The dam is considered to be in poor overall condition. The lack of any sort of operation and maintenance program has contributed to the deteriorated and unsafe conditions described in this section and listed below:

a. Broken handwheel operator and inoperable outlet valve;

b. Open joints at the stone masonry abutments and pier and open joints and bulges on the downstream face of the dam with associated excessive clear seepage below the mid-height of the dam (5 cfs);

c. Cracking of the concrete spillway caps;

d. Deteriorated condition of the pump house;

e. Growth of trees and brush at the abutments and on the dam;

f. Unsafe access across the top of the dam and to the low level outlet operator due to the lack of walkways on the access and service bridges, respectively.

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

a. General. According to Mr. James Cook, Engineer for the Town of Greenfield, the dam has been abandoned since the mid-1940's. Consequently, none of the facilities at the dam have been operated since that time.

b. Description of Any Warning System in Effect. According to the Owner's representative, during periods of extended snowmelt and/or rainfall, a representative of the Town of Greenfield Public Works Department periodically monitors conditions at both the Upper and Lower Glen (Greenfield) Reservoirs. The people in the downstream hazard area would be notified in the event that water levels approached the top of either dam.

4.2 Maintenance Procedures

a. General. According to the Owner's representative, because the dam is abandoned, no maintenance is performed.

b. Operating Facilities. According to the Owner's representative, neither of the outlets valves nor the pump house facilities have been maintained since around the mid-1940's and are now inoperable.

4.3 Evaluation

Lack of operation and maintenance of the dam has contributed to the overall unsafe and deteriorated conditions observed at the dam, as described in Section 3. A comprehensive operation and maintenance program should be developed and implemented and an annual technical inspection should be instituted. A more formal warning system should be developed.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Lower Glen (Greenfield) Reservoir has a steep and forested watershed of 5.4 square miles, ranging from El. 1275 in the upper reaches of Brandy Brook to El. 446 at normal pool elevation. Glen Brook, the primary tributary to Lower Glen (Greenfield) Reservoir, originates approximately 4.3 miles to the northwest of the dam and initially drains to Upper Glen (Greenfield) Reservoir. It continues for a distance of approximately 0.2 miles and collects surface runoff from an additional 0.2 square mile area before reaching Lower Glen (Greenfield) Reservoir Dam.

Upper Glen (Greenfield) Reservoir impounds 92 acre-feet of water at the normal pool El. 526.

Additional hydrologic information with respect to routing of the test flood is presented in Appendix D.

5.2 Design Data

Apparently, no hydrologic or hydraulic design information is available since none could be found in the files at the Town of Greenfield, Department of Public Works.

5.3 Experience Data

According to the Owner's representative, no stage records or records of any over-toppings of the dam are available.

5.4 Test Flood Analysis

The recommended test flood range for an "Intermediate" size, "Significant" hazard dam is from one-half of the Probable Maximum Flood (PMF) to the full PMF. Because of the potential for appreciable property damage, but little or no chance for loss of life at the downstream hazard area, the selected test flood is one-half of the PMF.

Hydrologic and hydraulic calculations were performed with the assistance of the HEC-1-DB computer program. Flood hydrographs were developed from Snyder unit hydrographs using average coefficients, an initial infiltration value of zero and a constant loss rate of 0.05 inches per hour. The Hop Brook Adjustment Factor[1] was used to reduce the probable maximum precipitation based upon the size of the drainage area. The routing sequence consisted of dividing the watershed into two sub-basins and routing the inflow hydrographs through the Upper and Lower Glen (Greenfield) Reservoirs, respectively. Stage vs. discharge and stage vs. storage relationships were developed for each dam to obtain outflow hydrographs. Each reservoir was assumed to be at its respective spillway crest at the beginning of the storm event.

[1]Corps of Engineers, Engineering Circular No. 1110-2-27, Aug. '66.

A total of 3,690 cfs was routed through Upper Glen (Greenfield) Reservoir Dam and then along Glen Brook to Lower Glen (Greenfield) Reservoir. A peak test flood outflow of 3,760 cfs with an overtopping depth of approximately 4.8 feet, was computed at Lower Glen (Greenfield)Reservoir Dam. The two spillways have a combined capacity of 740 cfs, or roughly 20 percent of the routed test flood outflow, with the reservoir pool at top of dam El. 470.5.

5.5 Dam Failure Analysis

Failure of the dam was simulated with the assistance of the HEC-1-DB computer program. The failure was assumed to be 25 feet wide by 40 feet deep with vertical side slopes, developing within one hour. The breach of the dam is assumed to occur with the reservoir surface at the crest of dam elevation. This is compared with discharges through the spillway system with the reservoir surface at the top of the dam with no failure.

The resulting outflow was routed along Glen Brook, through an arch culvert under Greenfield Road and approximately 400 feet further to a farm. The channel cross-section at this location is shown on page D-14. The stream depths at the hazard area where computed to be 3.5 feet and 3.0 feet for the breach and non-breach conditions, respectively. The discharges at the hazard area were computed to be 1,540 cfs and 750 cfs for the breach and non-breach conditions, respectively. It is anticipated that Glen Brook would overflow its banks and flood the first floor of the farm house to a depth of 0.5 feet for the breach condition. For the non-breach condition water would reach the level of the first floor. Appreciable damage would be expected, but little or no chance for loss of life would be anticipated.

SECTION 6

STRUCTURAL STABILITY

6.1 Visual Observations

The dam was observed to be in poor overall condition. Many open joints, averaging about 0.5 inches, were observed at the abutments and in the downstream face of the dam, particularly at the east side groin area illustrated in photo 5 of Appendix C and at the "bulge" observed just to the east of the center pier at about mid-height of the dam also shown in photo 5. A great deal of clear seepage (5 cfs) was observed spurting from the cracks. The west side abutment appears to be structurally sound.

6.2 Design and Construction Data

According to the Owner's representative, no design or construction data is available.

6.3 Post Construction Changes

According to the Owner's representative, it is not known whether any modifications have been made since the dam was constructed in 1904. It does not appear that any major structural changes have been made.

6.4 Seismic Stability

Lower Glen (Greenfield) Reservoir Dam is located in seismic Zone 2 on the "Seismic Zone Map of Contiguous States". Therefore, according to the Recommended Guidelines for Phase I Dam Inspections, the dam need not be evaluated for seismic stability.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. From visual inspection, it is apparent that the dam is in poor overall condition. The dam is essentially abandoned, it serves no specific purpose and consequently, has not been operated or maintained for more than 30 years.

There are two major safety concerns. Because the dam is in such poor structural condition, it is unlikely that the dam could withstand even moderate overtopping. The other condition concerns safety at the site. Lack of an adequate means of crossing the dam not only prevents safe operation and maintenance, but also presents an unsafe condition for personnel who visit the site, for whatever reason.

The computed test flood outflow of 3,760 cfs is approximately five times greater than the capacity of the existing spillway system. The outflow produced by routing of the test flood through the reservoir should not significantly affect downstream areas, but because of the condition of the dam, it is possible that the dam might fail under the forces created by a projected overtopping depth of 4.8 feet. If the dam were to fail, assuming the conditions discussed in Section 5, one residence located approximately 1.6 miles downstream of the dam could expect flooding to a depth of approximately 0.5 feet above the first floor elevation.

b. Adequacy of Information. The drawing, along with information obtained during the visual inspection of the dam, proved adequate for a Phase I assessment of Lower Glen (Greenfield) Reservoir Dam.

c. Urgency. The recommendations and remedial measures described in Sections 7.2 and 7.3 should be implemented within one year of receipt of this Phase I Inspection Report.

7.2 Recommendations

The Owner, the Town of Greenfield, should retain the services of a qualified, registered professional engineer, experienced in the design and construction of dams for the following purposes:

1. Perform detailed structural stability analyses of the dam and recommend measures to be taken to insure its structural integrity.

2. Perform detailed hydrologic and hydraulic analyses to assess the need for increasing the project discharge capacity and to evaluate the ability of the structure to withstand overtopping.

3. Investigate the source and nature of the clear spurting seepage observed along the downstream face of the dam.

4. Design and direct the installation of a reservoir drawdown system.

5. Direct the removal of trees and their root systems from the dam and direct the replacement of affected stone masonry units in the dam.

7.3 Remedial Measures

The Owner, the Town of Greenfield, should also implement the following operation and maintenance procedures:

1. Repair the access bridges.

2. Institute a program of annual technical inspection of the dam.

3. Establish and implement a regular maintenance program for the dam.

4. Develop a formal downstream warning system.

7.4 Alternatives

As an alternative to the above recommendations and remedial measures, the lake could be drained and the dam removed.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST

INSPECTION TEAM ORGANIZATION

Project: Lower Glen Reservoir Dam

National I.D.#: MA 00048

Location: Leyden, Massachusetts

Type of Dam: Stone Masonry

Inspection Date(s): December 3, 1980

Weather: Overcast, 40's

Pool Elevation: 466+ MSL

Inspection Team

Lee DeHeer	O'Brien & Gere	Managing Engineer
Leonard Beck	O'Brien & Gere	Structures
Steven Snider	O'Brien & Gere	Foundations & Materials
Alan Hanscom	O'Brien & Gere	Structures
Denis Mehu	Bryant & Associates	Hydrology/Hydraulics

Owner's Representative

Mr. James Cook, Town Engineer; Town of Greenfield, Massachusetts; 01301.

(413/772-0166)

VISUAL INSPECTION CHECK LIST

Project: Lower Glen Reservoir Dam

National I.D. #: MA 00048

Date(s): December 3, 1980

AREA EVALUATED	CONDITIONS
CONCRETE/MASONRY DAM	
Crest Elevation	470.5± NGVD
Current Pool Elevation	466± NGVD
Maximum Impoundment to Date	Unknown
Any Noticeable Seepage	Much seepage just to the east of the dam center and below mid-height of the dam (See Photo 5)
Conditions of Abutment	Near vertical outcropping of stone, Looks reasonably sound (each side)
Drains	None observed
Water Passages	Not applicable
Foundation	Founded on stone
Masonry/Concrete Surface Cracks	Little or no mortar between stone blocks, superficial cracking at concrete cap
Structural Cracking	Structural movement has widened cracks
Vertical and Horizontal Alignment	Misalignment of vertical face (See Photo 5)
Monolith Joints	Little or no mortar, some patching evident
Construction Joints	Not applicable
Upstream Embankment	Submerged
Instrumentation System	Not applicable
Inspection Galleries	Not applicable

VISUAL INSPECTION CHECK LIST

Project: Lower Glen Reservoir Dam

National I.D. #: MA 00048

Date(s): December 3, 1980

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel (Apron)	
General Condition	Submerged, appears to be fair
Loose Rock Overhanging Channel	Not applicable
Trees Overhanging Channel	Not applicable
Floor of Approach Channel	Sloped slightly upstream, some slight spalling observed
b. Weir and Training Walls	
General Condition of Concrete	Fair
Rust or Staining	Center abutment, superficial staining (See Photo 1)
Spalling	Slight (Discharge Apron)
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	None observed
Drain Holes	None observed
c. Discharge Channel	
General Condition	Fair

VISUAL INSPECTION CHECK LIST

Project: Lower Gler Reservoir Dam

National I.D. #: MA 00048

Date(s): December 3, 1980

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS (Con't)	
Loose Rock Overhanging Channel	Few
Trees Overhanging Channel	Few, Not Significant
Floor of Channel	Mostly natural outcropping of stone
Other Obstructions	Minor debris: logs, brush, stone, etc. in channel

VISUAL INSPECTION CHECK LIST

Project: Lower Glen Reservoir Dam

National I.D. #: MA 00048

Date(s): December 3, 1980

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	None (See Photo 1)
Bearings	Not applicable
Anchor Bolts	Appear to be secure
Bridge Seat	Not applicable
Longitudinal Members	Corroded
Under Side of Deck	Missing
Secondary Bracing	None
Deck	Missing
Drainage System	Not applicable
Railings	None
Expansion Joints	None
Paint	None
b. Abutment & Piers	
General Condition of Concrete	Fair
Alignment of Abutment	Appears to be aligned

VISUAL INSPECTION CHECK LIST

Project: Lower Glen Reservoir Dam

National I.D. #: MA 00048

Date(s): December 3, 1980

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SERVICE BRIDGE (Con't)	
Approach to Bridge	Unsafe
Condition of Seat & Backwall	Not applicable

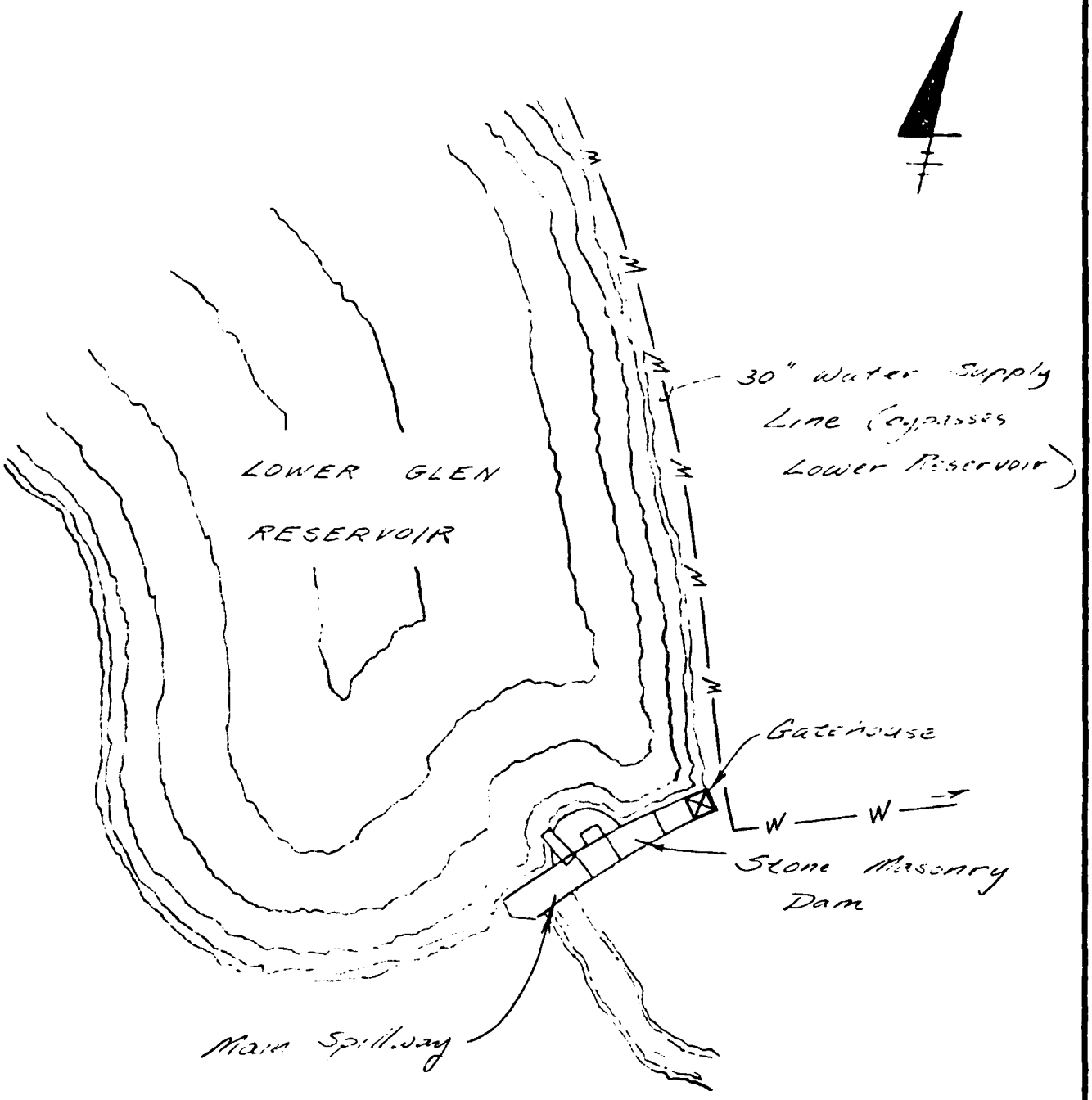
APPENDIX B

ENGINEERING DATA

LOWER GLEN RESERVOIR

APPENDIX B

ENGINEERING DATA



Note: This drawing was reproduced from a March, 1904 Plan furnished by the Town of Greenfield. (signed by Chas. J. Day, Engineer)

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DIVISION

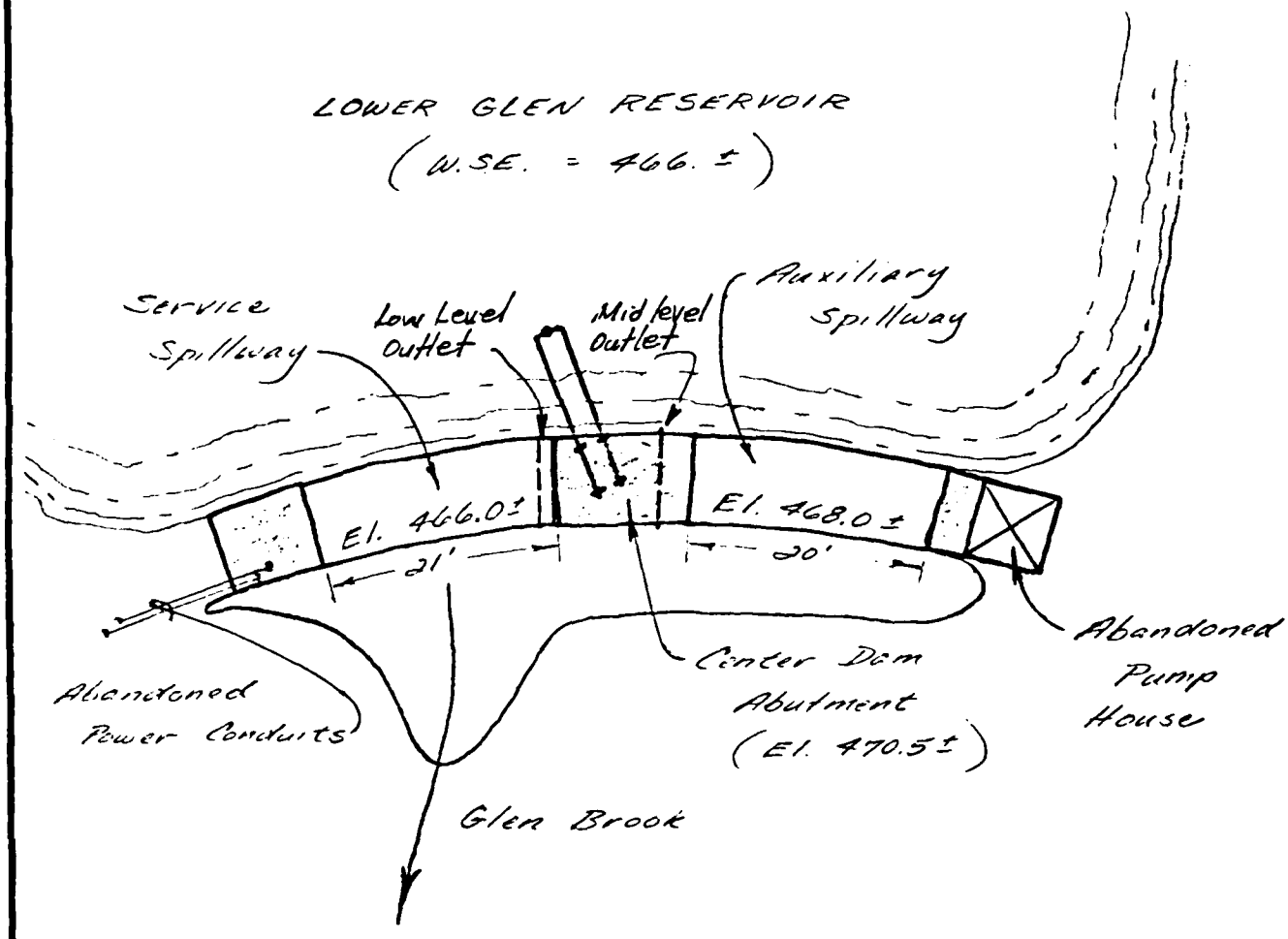
CONTRACT NO. DACW 33-81-C-0016
LOWER GLEN RESERVOIR DAM

PLAN OF DAM & APPURTENANCES

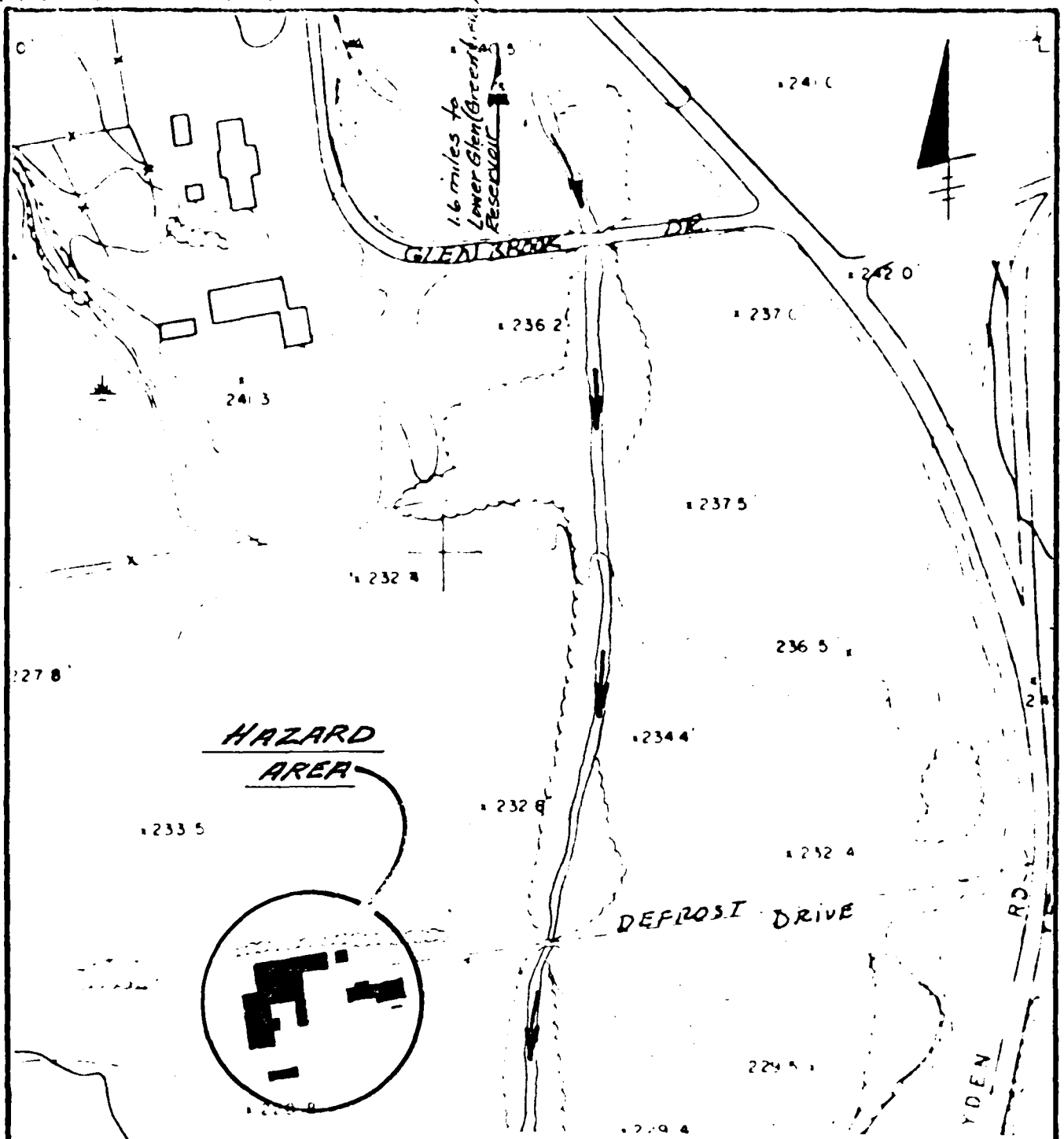
O'BRIEN & GERE

Date: 1/81
Scale: 1"=60'

B-1



U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		
CONTRACT NO. DACW 33-81-C-0016 LOWER GLEN RESERVOIR DAM		
FIELD SKETCH		
O'BRIEN & GERE	Date: 12/3/80 Scale: None	B-2



Note: This drawing was reproduced from Town of Greenfield Flood Insurance Map 5-E, photo date April 19, 1970.

U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		
CONTRACT NO. DACW 33-81-C-0016 LOWER GLEN RESERVOIR DAM		
MAP OF HAZARD AREA		
O'BRIEN & GERE	Date: Jan.,1981 Scale: 1"=200'	B-3

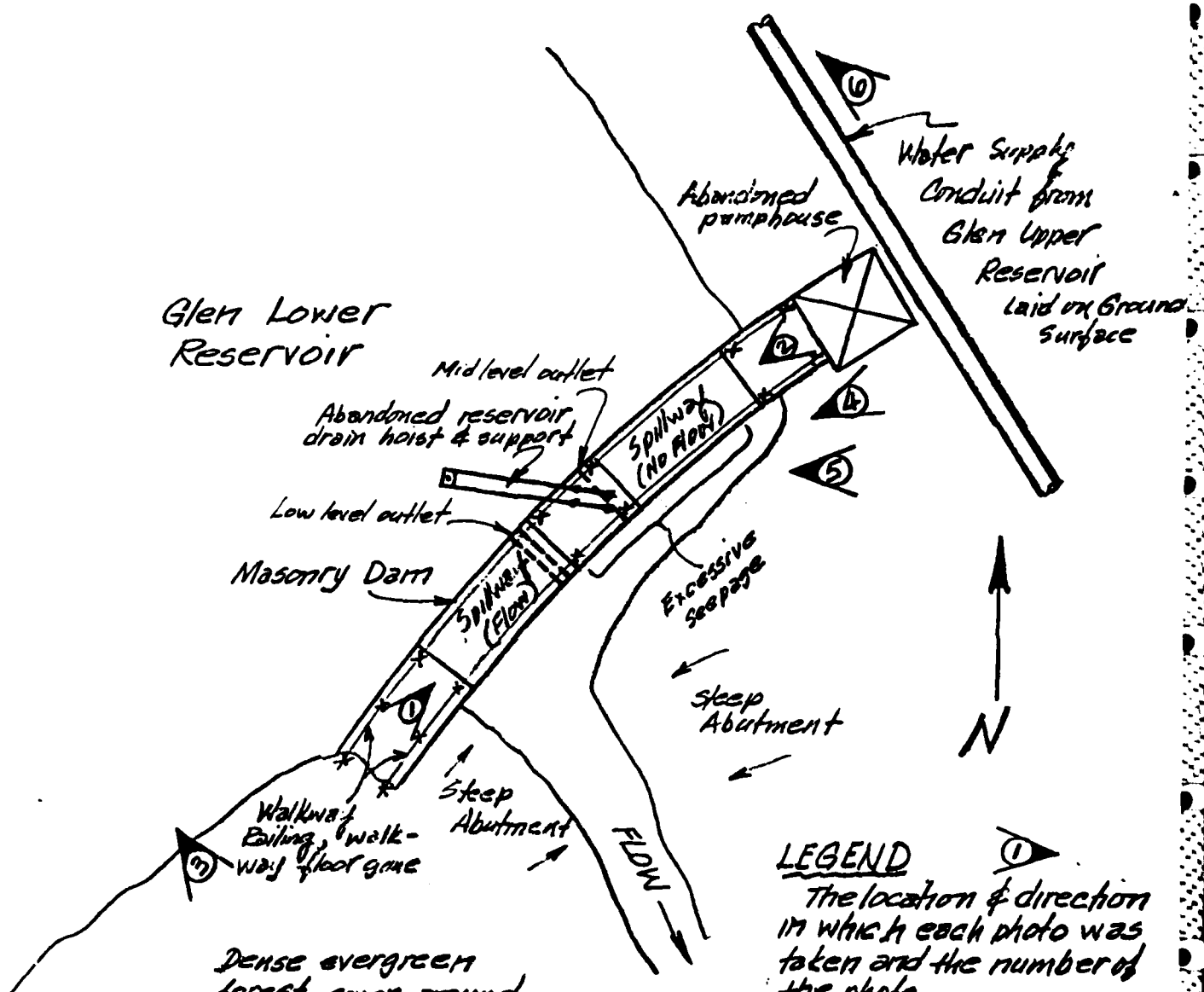
APPENDIX C

PHOTOGRAPHS

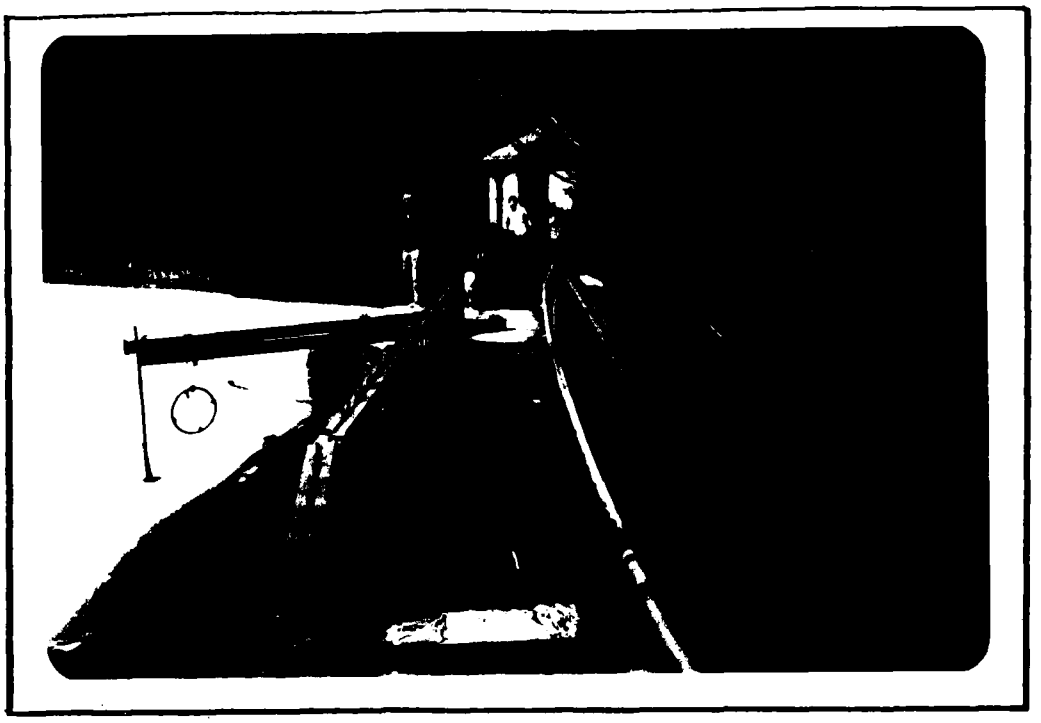
APPENDIX C
SELECTED PHOTOGRAPHS OF THE PROJECT

O'BRIEN & GERE ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Glen Lower Reservoir Dam	A	[illegible]	12/26/80	2060-002

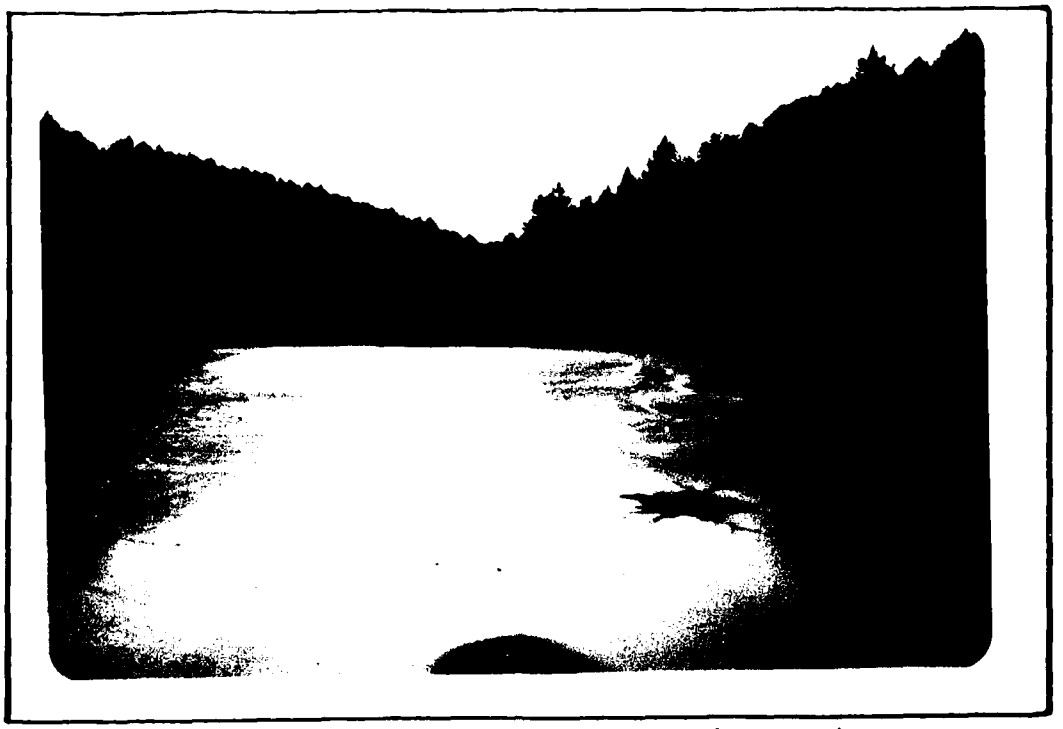


SITE PLAN



1. VIEW ACROSS CREST OF DAM FROM THE RIGHT ABUTMENT SHOWING THE INOPERABLE RESERVOIR DRAIN HOIST AND THE ABANDONED PUMPHOUSE IN THE BACKGROUND. (12/3/80)

2. VIEW ACROSS CREST OF DAM FROM THE ABANDONED GATEHOUSE AT THE LEFT ABUTMENT. (12/3/80)



3. THE IMPOUNDMENT AS SEEN FROM THE DAM. (12/3/80)

4. DOWNSTREAM FACE OF THE DAM SHOWING A TREE GROWING BETWEEN THE MASONRY BLOCK. (12/3/80)

5. DOWNSTREAM FACE OF THE DAM SHOWING THE MISALIGNMENT OF THE WALL AND THE EXTENSIVE SEEPAGE DISCHARGING FROM THE WALL. (12/3/80)

6. THE WATER SUPPLY LINE FROM GLEN UPPER RESERVOIR LOCATED ALONG THE EASTERN BANK OF THE GLEN LOWER RESERVOIR. (12/3/80)

7. CULVERT AND TYPICAL STREAM CHANNEL ABOUT 1.1 MILES DOWNSTREAM OF THE DAM. (12/3/80)

8. POTENTIAL DAMAGE AREA APPROXIMATELY 1.6 MILES DOWNSTREAM OF THE DAM. (12/3/80)

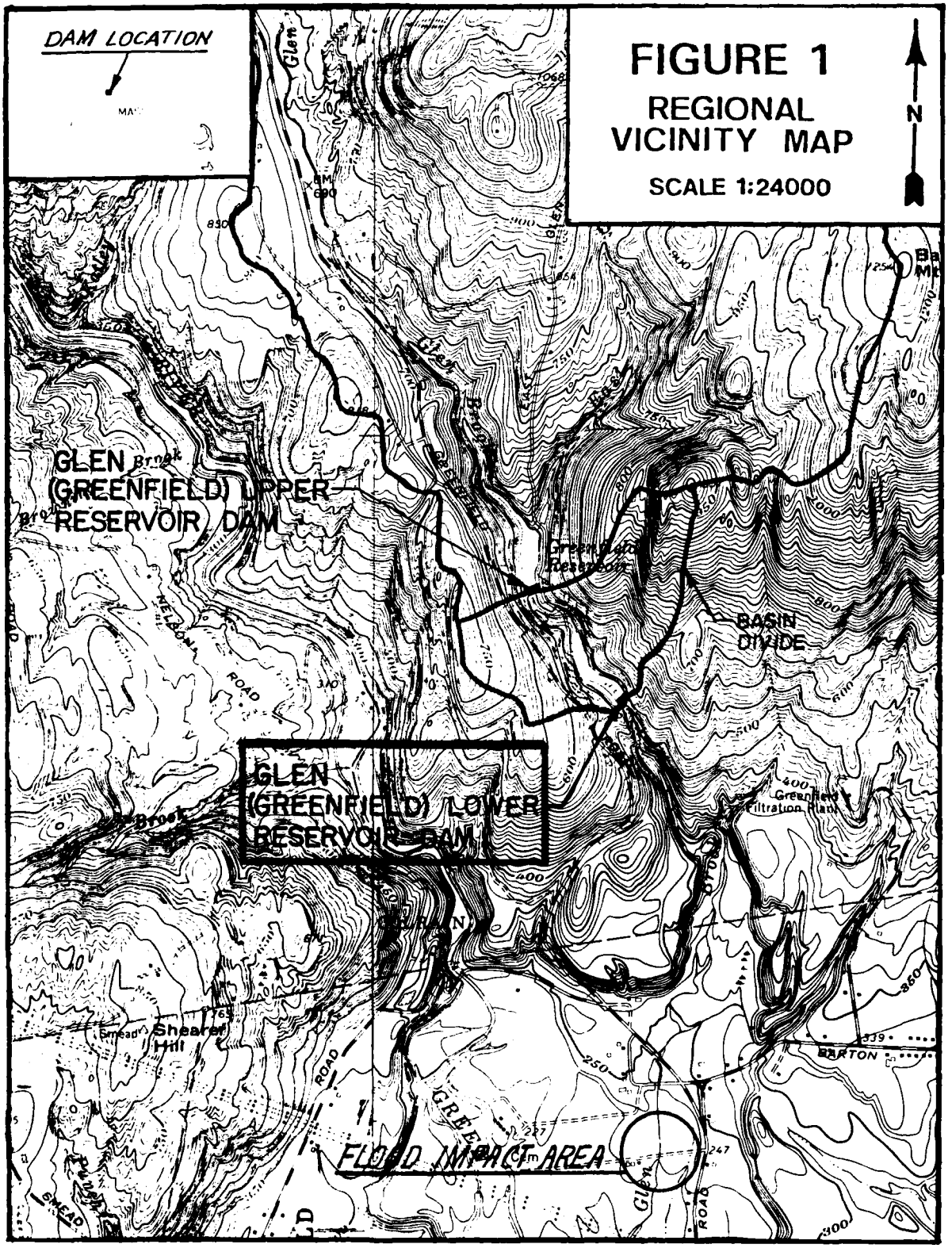
APPENDIX D

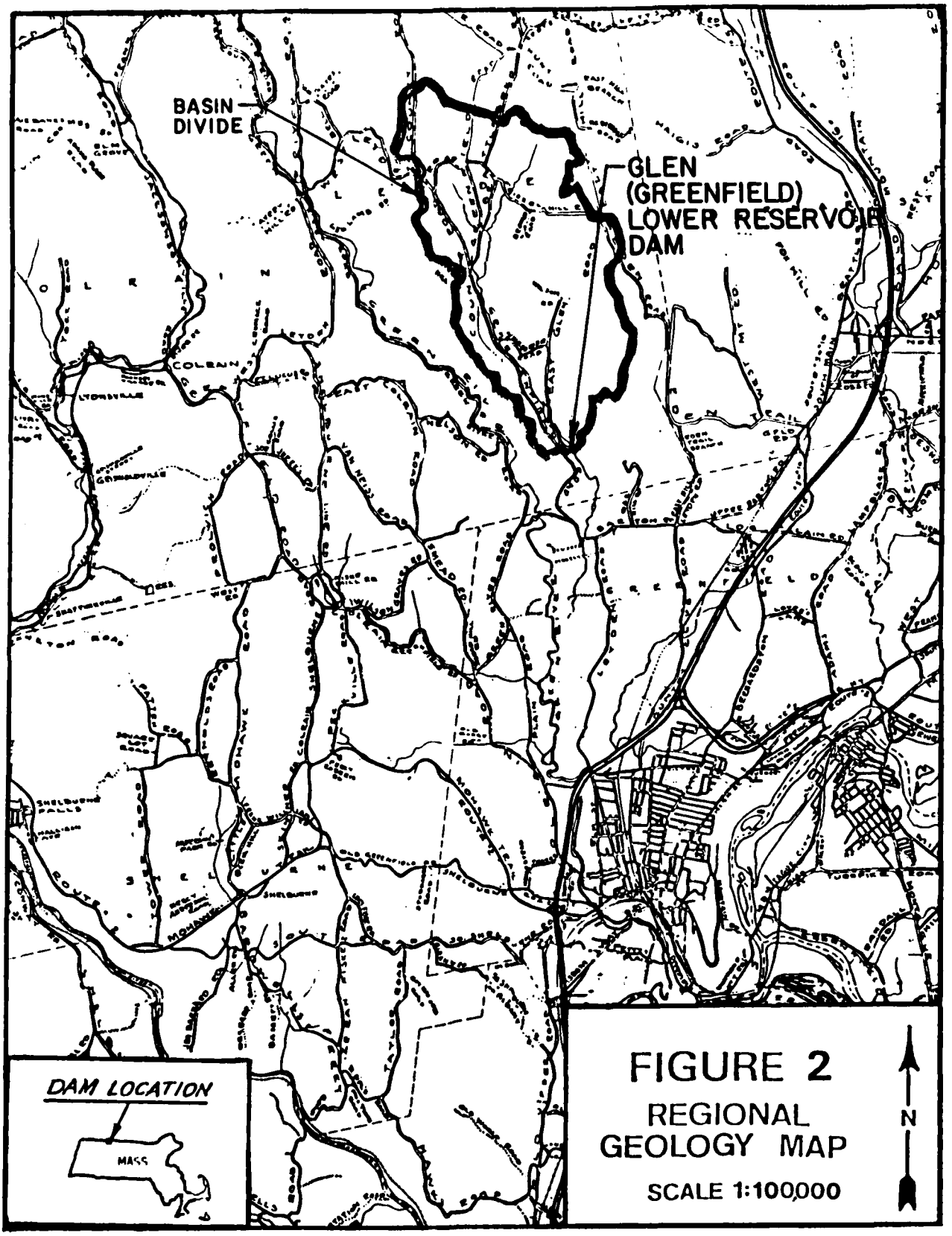
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

APPENDIX D

HYDROLOGIC & HYDRAULIC COMPUTATIONS

TABLE OF CONTENTS


DAM LOCATION
FIGURE 1
REGIONAL
VICINITY MAP
SCALE 1:24000
N
GLEN (GREENFIELD) UPPER RESERVOIR DAM
GLEN (GREENFIELD) LOWER RESERVOIR DAM
BASIN DIVIDE
Greenfield Filtration Plant
Shearer Hill
BARTON
FLOOD IMPACT AREA
KELBOURN ROAD
GREENFIELD ROAD


BASIN DIVIDE
GLEN (GREENFIELD) LOWER RESERVOIR DAM
COLRAIN
DAM LOCATION
MASS
FIGURE 2
REGIONAL GEOLOGY MAP
SCALE 1:100,000
N

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-3	ADH	12/09/80	2060.002

(I.) Drainage Area . . . 5.4 sq. mi.

(II.) Snyder Hydrograph Coefficients

$C_t = 2.0$ & $C_p = 0.5$

(III.) T_p Calculation (For Lower Glen sub watershed only)

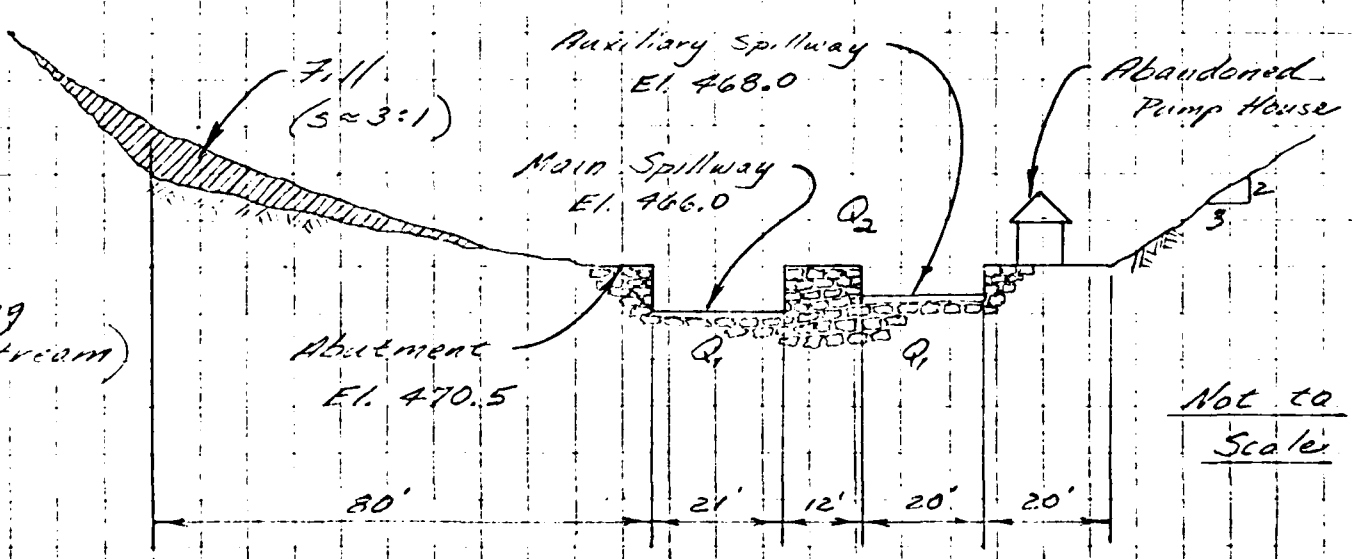
$$T_p = C_t (L \times L_{ca})^{0.3}$$

where L = main channel length from the outflow point to the upstream watershed boundary (river miles) and

L_{ca} = main channel length from the outflow point to a point opposite the center of the river basin (river miles)

$\Rightarrow T_p = (2.0)(.63 \times .37)^{.3} = 1.18$ hr → say 1.25 Hours

(III.) Sketch: Dam Elevation & Spillway Dimensions



O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-4	ADH	12/12/80	3060.002

(V.) Stage - Discharge Relationship *

Elevation (NGVD)	H_1 (ft)	Q_1 (cfs)	H_2 (ft)	Q_2 (cfs)	ΣQ (cfs)
466	0	0	—	—	0
467	1	56	—	—	56
468	2	157	—	—	157
469	3	342	—	—	342
470	4	595	—	—	595
470.5	4.5	741	0	0	741
471	5	783	0.5	36	819
472	6	960	1.5	213	1,173
473	7	1,211	2.5	527	1,738
474	8	1,520	3.5	949	2,469
475	9	1,876	4.5	1,523	3,399
476	10	2,275	5.5	2,244	4,519
477	11	2,711	6.5	3,124	5,835
478	12	3,183	7.5	4,170	7,353
479	13	3,688	8.5	5,390	9,078
480	14	4,223	9.5	6,793	11,016
481	15	4,786	10.5	8,387	13,173

* Flows have been calculated based upon the weir flow formula: $Q = CLH^{3/2}$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-3	ADH	12/12/80	2060.002

Flow Coefficients: (Broad-crested weir)

C = 2.65 for flow over spillway up to top of dam elevation 470.5

C = 2.9 for flow over dam and for flows over the spillway above elevation 470.5

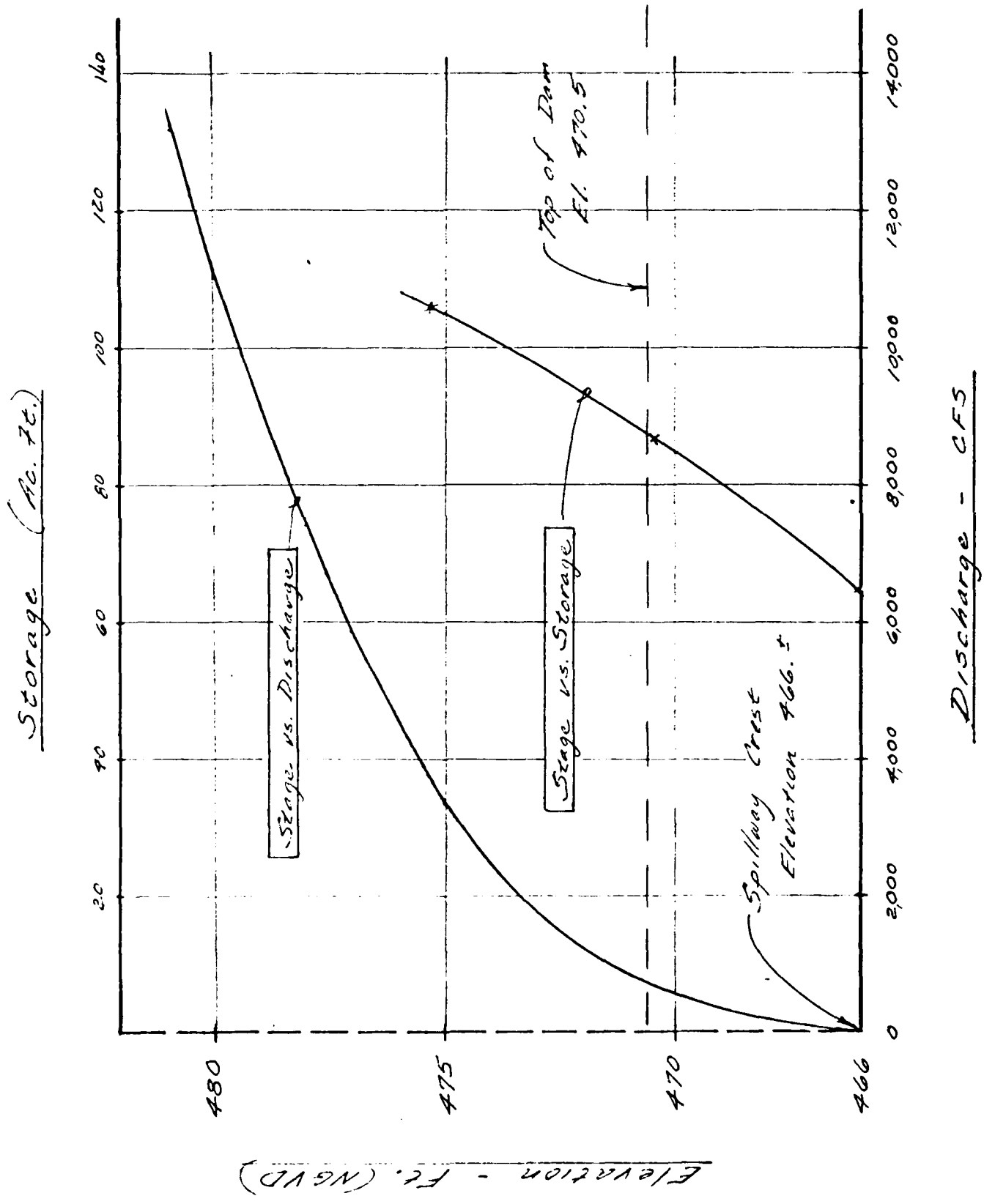
(VI.) Stage - Storage Relationship*

Description	Elevation (NGVD)	Area (acres)	Storage (acre-feet)
Toe of Dam	424.5	0	0
Spillway Crest	466.0	4.8	64
Top of Dam	470.5	5.1	87
Test Flood El.	475.3	5.7	114

* Areas have been determined from USGS maps, unless more detailed survey information was available. Storage data have been computed according to the conical method by the HEC-1 program.

O'BRIEN & GERE
ENGINEERS, INC

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-3	ADH	12/12/80	2060.002



O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-.	ADH	12/12/80	2060.002

(VIII.) PMP DATA (Total D.A. ≈ 5.4 mi.^{2})

24-Hr. 200 mi^2 probable maximum precipitation

= 20.2 inches (Ref. HMS #33)

Also,

6-Hr. % of index for this basin ≈ 111

12-Hr. " " " " " " ≈ 123

24-Hr. " " " " " " ≈ 132

(IX.) Upstream Routing Information

The flood routing for Lower Glen Reservoir Dam must first be routed through Upper Glen Reservoir and through a portion of Glen Brook just upstream of Lower Glen Reservoir. Pertinent upstream routing information is presented in this Section.

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-	ADH	12/15/80	3060.002

Upper Glen Reservoir Dam - H&H

Drainage Area - 5.02 sq. mi.

Snyder Hydrograph Coefficients

$C_t = 2.0$ & $C_p = 0.5$

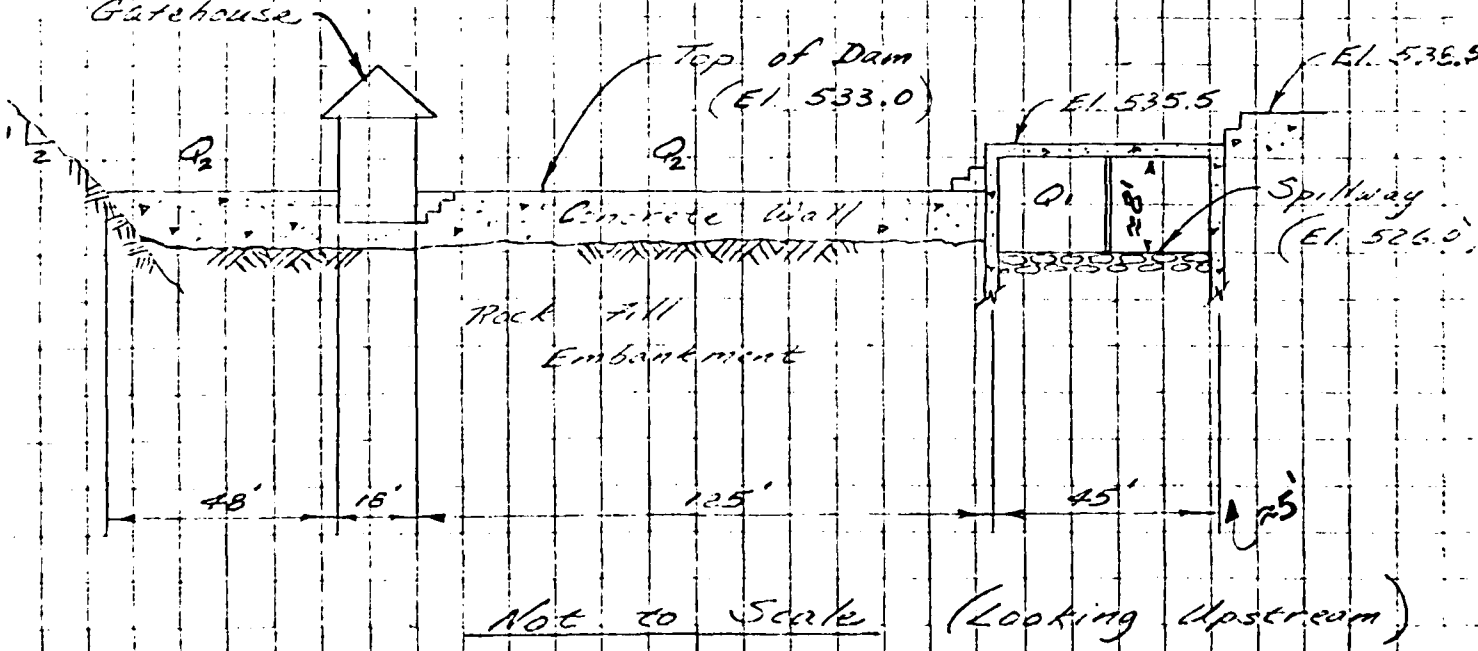
Tp Calculation

$$T_p = C_t (L \times L_{ca})^{0.3} = (2.0)(.52 \times 2.4)^{.3} = 4.25 \text{ Hours}$$

where L = main channel length from the outflow point to the upstream watershed boundary (river miles) and

L_{ca} = main channel length from the outflow point to a point opposite the center of the river basin (river miles)

Sketch: Dam Elevation & Spillway Dimensions



Not to Scale (Looking Upstream)

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-1	ADH	12/15/80	3060.002

Upper Glen Reservoir Dam - H&H

Stage - Discharge Relationship

Elevation (NGVD)	H_1 (ft)	Q_1 (cfs)	H_2 (ft)	Q_2 (cfs)	ΣQ (cfs)
526	0	0	—	—	0
527	1	117	—	—	117
528	2	330	—	—	330
529	3	606	—	—	606
530	4	933	—	—	933
531	5	1,304	—	—	1,304
532	6	1,714	—	—	1,714
533	7	2,160	0	0	2,160
534	8	2,638	1	502	3,140
535	9	2,686	2	969	3,657
535.5	9.5	2,733	2.5	1,983	4,716
536	10	3,156	3	3,285	6,441
537	11	3,865	4	5,058	8,923
538	12	4,463	5	7,068	11,531

Formulas:

Broad-crested Weir → $Q = CLH^{3/2}$

where $C = 2.65$ at spillway

$C = 2.9$ over dam

Submerged Spillway Inlet → $Q = Ca\sqrt{2gh}$

where $C = 0.79$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-1	ADH	12/15/80	2060.002

Upper Glen Reservoir Dam - H&H

Stage - Storage Relationship*

Description	Elevation (NGVD)	Area (acres)	Storage (acre-feet)
Toe of Dam	481.0	0	0
Spillway Crest	526.0	6.7	92
Top of Dam	533.0	7.1	143
Test Flood El.	535.0	7.7	159

* Areas have been determined from USGS maps, unless more detailed survey information is available. Storage data have been computed according to the conical method by the HEC-1 program.

PMP DATA (Total D.A. ≈ 5.2 mi.²)

24-Hr. 200 mi.² probable maximum precipitation

= 20.2 inches (Ref.: HMS #33)

Also,

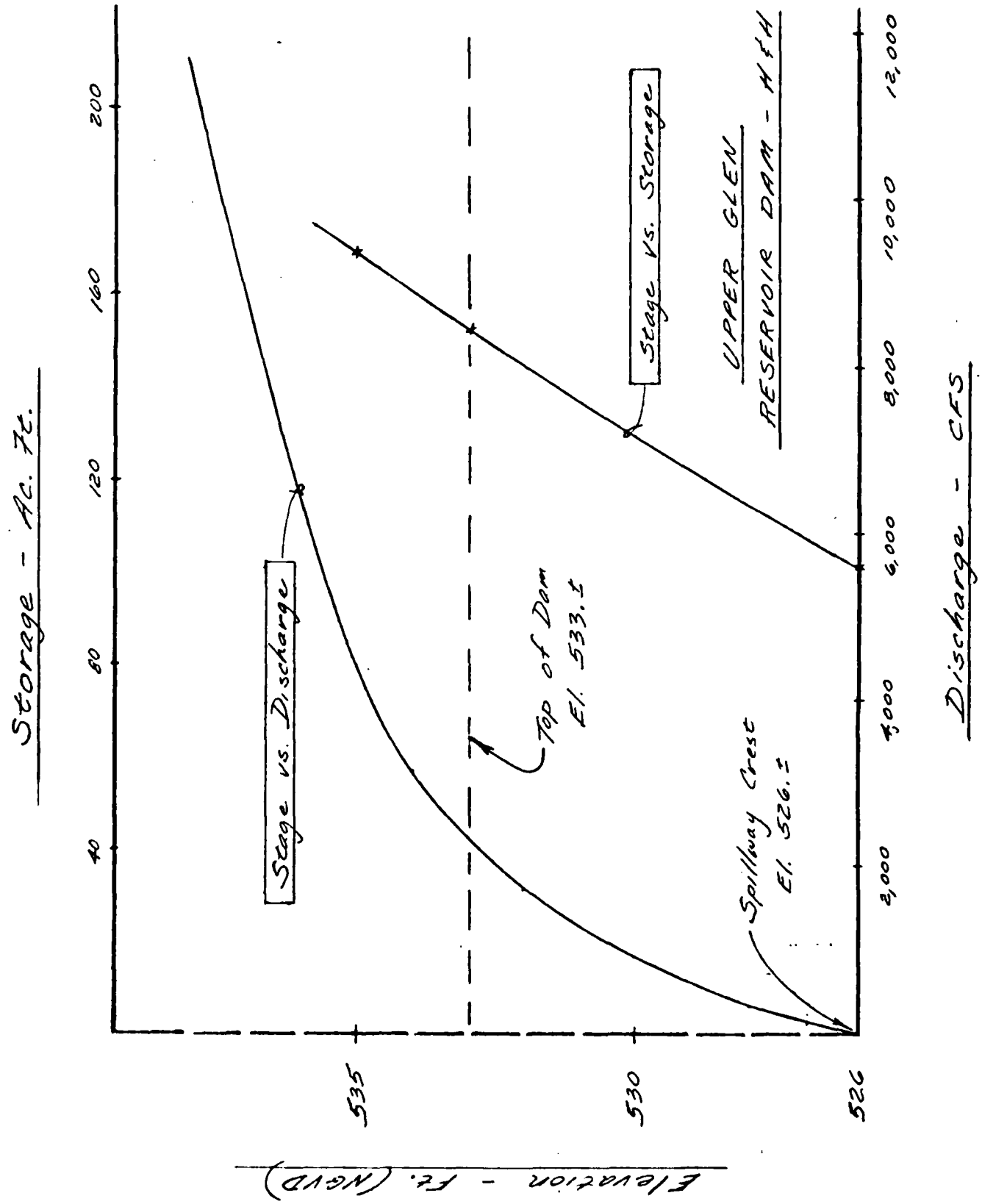
6-Hr. % of index for this basin ≈ 111

12-Hr. " " " " " " ≈ 123

24-Hr. " " " " " " ≈ 132

O'BRIEN & GERE
ENGINEERS, INC.

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-1.	ADH	12/13/80	2060.002

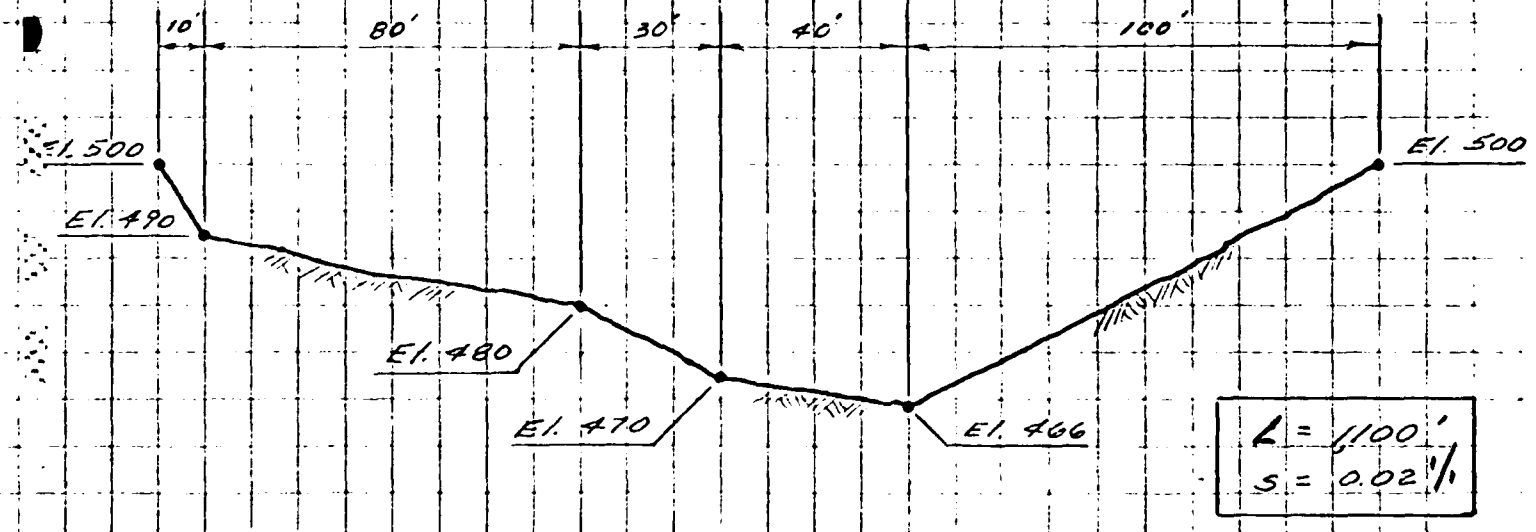


O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-13	ADH	12/15/80	3060.002

(IX.) Upstream Routing Information (Cont.)

In performing the routing analysis of Lower Glen Reservoir Dam, it is necessary to route the test flood passing Upper Glen Reservoir through a short reach of Glen Brook. A typical channel cross section just upstream of Lower Glen Reservoir is illustrated below.



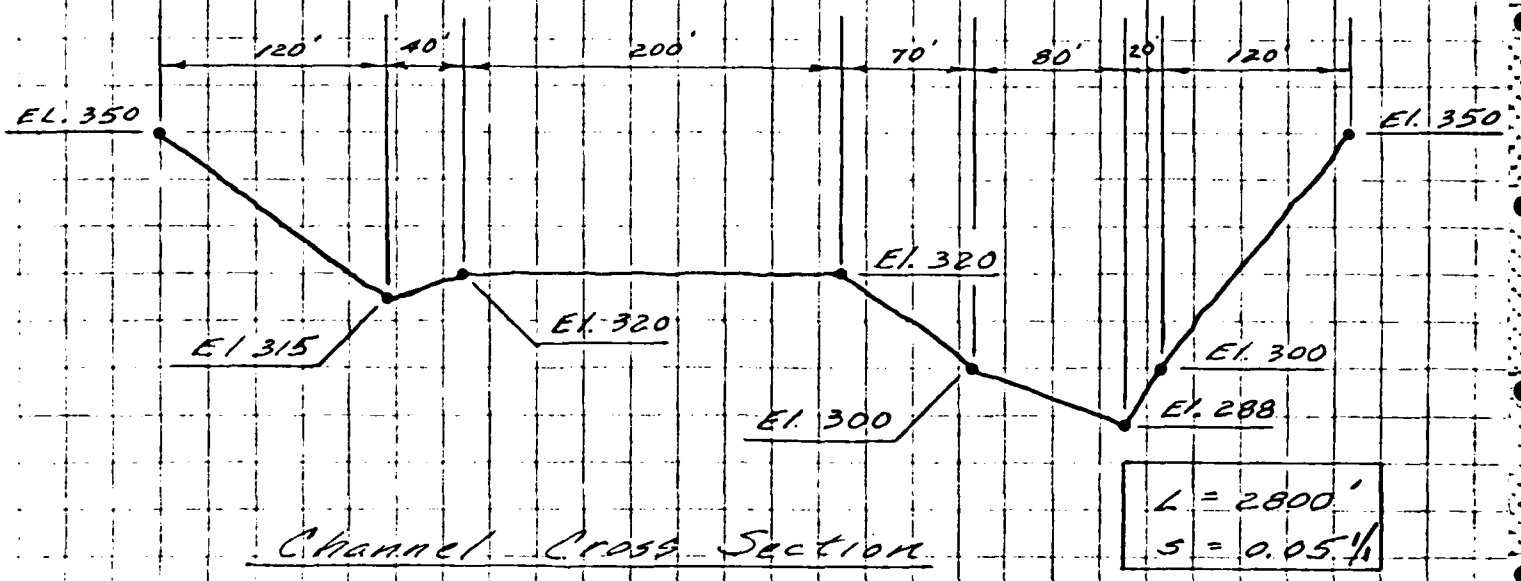
Channel Cross Section (CHANLO)

(just upstream of Lower Glen Reservoir)
(looking upstream)

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-1.	ADH	12/16/80	3060.00.2

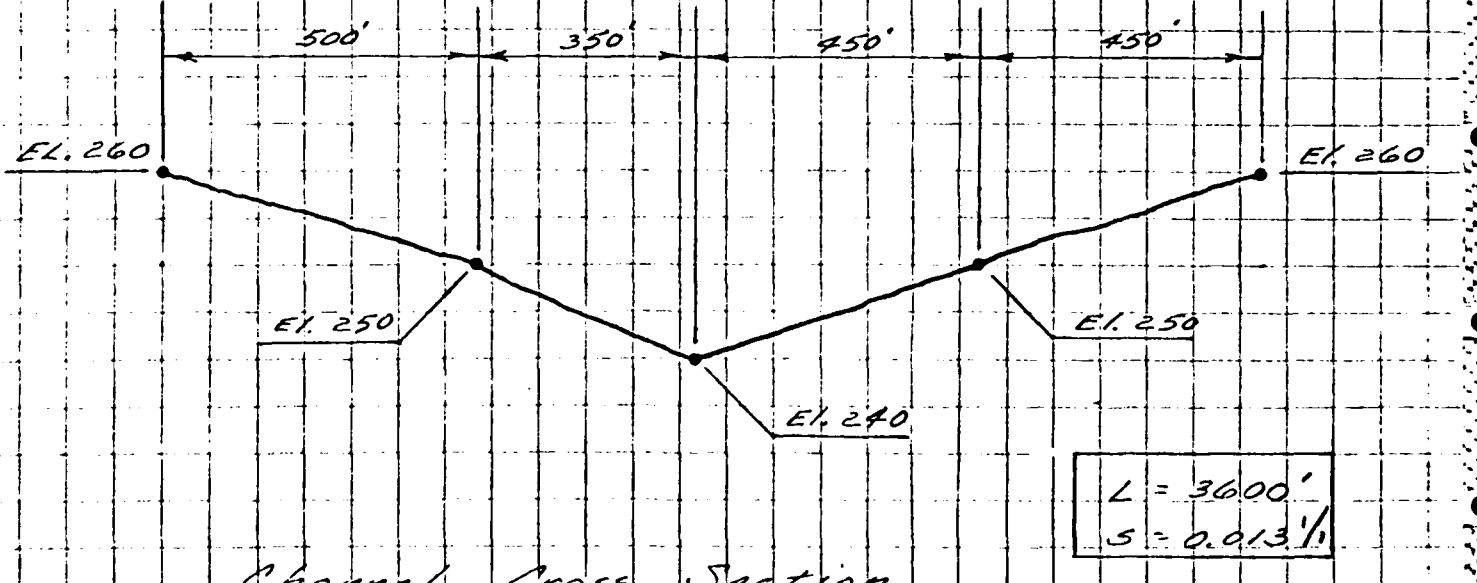
(VIII.) Downstream Routing Information



Channel Cross Section

(Stream Transection No. 1)

(looking upstream)



Channel Cross Section

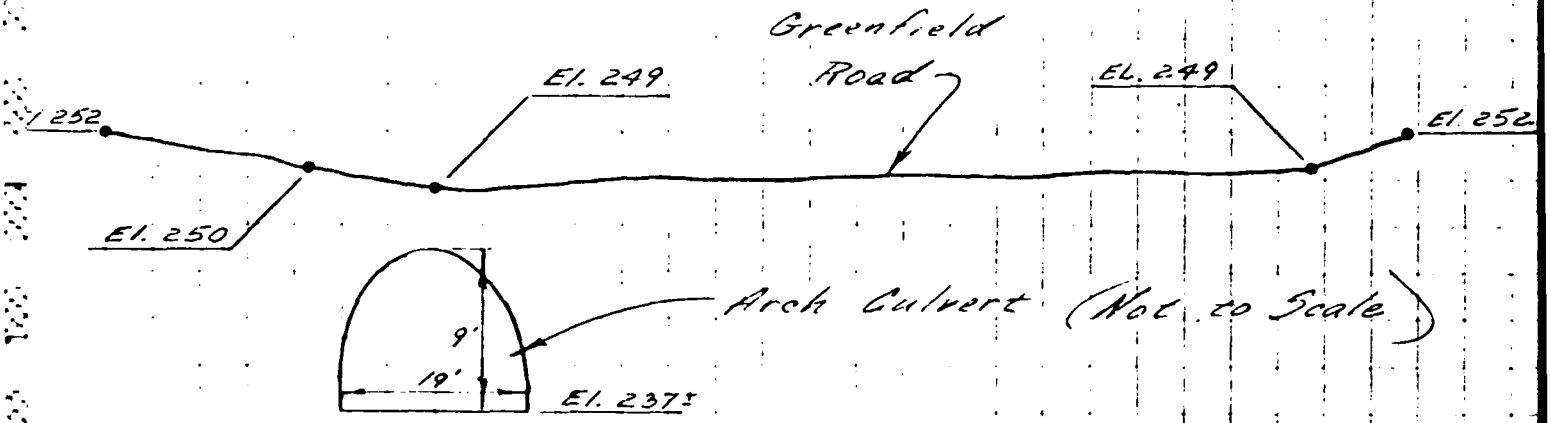
(Stream Transection No. 2)

(looking upstream)

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Lower Glen Reservoir Dam	D-14	ADH	12/16/80	3060.00.2

(VIII.) Downstream Routing Information (Cont.)



Arch Culvert (Not to Scale)

Cross Section - Greenfield Road Culvert

(looking downstream)

Stage - Discharge Tabulation - Greenfield Rd. Culvert

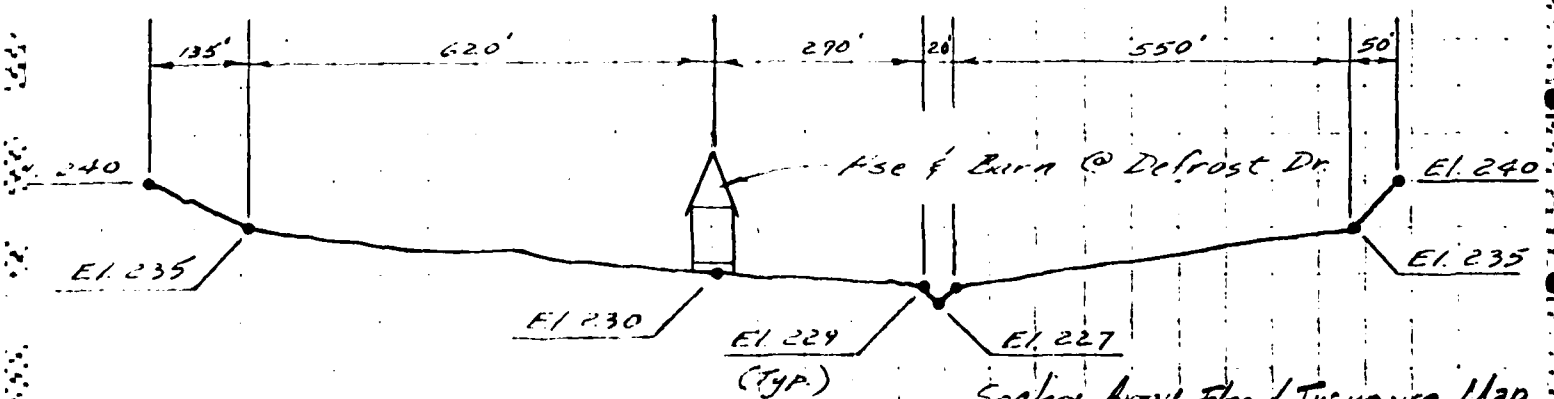
Elevation (NGVD)	H_1 (ft.)	Q* (cfs)
237	0	0
238	1	125
239	2	324
240	3	529
241	4	714
242	5	868
243	6	983
244	7	1060

Elevation (NGVD)	H_1 (ft.)	Q (cfs)
245	8	1,096
246	9	1,113
247	10	1,159
248	11	1,269
249	12	1,371
250	13	3,946
251	14	8,622
252	15	18,391

* see next page

(VIII.) Downstream Routing Information (Cont.).

NOTE: The stage-discharge relationship for the Greenfield Road culvert crossing was developed using the orifice equation for flow through the culvert ($Q = Ca\sqrt{2gh}$) and the standard weir flow equation for flow over the road ($Q = CLH^{3/2}$). The coefficients were chosen to be 0.68 and 3.1, respectively. Also, for open channel flow through the culvert, Manning's Equation was used. ($Q = \left(\frac{1.49}{n}\right) A R^{2/3} S^{1/2}$) Values of 0.025 and 0.02 were assumed for "n" and "S", respectively.



Section from Flood Insurance Map 5-E 4/19/70

Channel Cross Section @ Hazard Area

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DA FET (SID JU 1978
LAST MODIFICATION 26 FEB 79

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**********
  1          A1          HYDROLOGIC ANALYSIS OF LOWER GLEN RESERVOIR DAM
  2          A2                    NATIONAL DAM INSPECTION PROGRAM
  3          A3          NEW ENGLAND DIVISION - CORPS OF ENGINEERS
  4          B    300       0       15        0        0        0        0        0       -4        0
  5          B1     5
  6          J      1       9        1
  7          J1    .2      .3       .4       .5       .6       .7       .8       .9      1.0
  8          K      0   INFUP                                                  1
  9          K1                   INFLOW TO UPPER GLEN RESERVOIR
 10          M      1       1      5.2                 0                                 1
 11          P      0    20.2      111      123      132
 12          T                                                              0     0.05
 13          W   4.25     0.6
 14          X   -1.7    -0.1        2
 15          K      1   OUTUP                                                  1
 16          K1                 ROUTED OUTFLOW FROM UPPER GLEN RESERVOIR
 17          Y                                    1        1
 18          Y1     1                                                     -526     -1
 19          Y4   526      527      528      529      530      531      532      533      534      535
 20          Y4 535.5      536      537      538      539
 21          Y5     0      117      330      606      933     1304     1714     2160     3140     3657
 22          Y5  4716     6441     8923    11531    14602
 23          $A     0      6.7      9.3
 24          $E   481      526      540
 25          $$   526
 26          $D   533
 27          K      0   INFLO                                                  1
 28          K1                 INFLOW TO LOWER RES LESS UPPER RES
 29          M      1       1      0.2                5.9
 30          P      0    20.2      111      123      132
 31          T                                                              0     .05
 32          W   1.25     0.6
 33          X   -1.7    -0.1        2
 34          K      2   ADD                                                    1
 35          K1                          COMBINE HYDROGRAPHS
 36          K      1   OUTLO                                                  1
 37          K1                 ROUTED OUTFLOW FROM LOWER GLEN RESERVOIR
 38          Y                                    1        1
 39          Y1     1                                                     -466     -1
 40          Y4   466      467      468      469      470    470.5      471      472      473      474
 41          Y4   475      476      477      478      479      480      481
 42          Y5     0       56      157      342      595      741      819     1173     1738     2469
 43          Y5  3399     4519     5835     7353     9078    11016    13173
 44          $A     0      4.8      7.1
 45          $E   426      466      485
 46          $$   466
 47          $D 470.5
 48          K     99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                           RUNOFF HYDROGRAPH AT          INFUP
                           ROUTE HYDROGRAPH TO           OUTUP
                           RUNOFF HYDROGRAPH AT          INFLO
                           COMBINE  2 HYDROGRAPHS AT     ADD
                           ROUTE HYDROGRAPH TO           OUTLO
                           END OF NETWORK
```

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MADE IN U.S.A.

****

DATE 80/12/22.
TIME 11.40.55.

HYDROLOGIC ANALYSIS OF LOWER GLEN RESERVOIR DAM
NATIONAL DAM INSPECTION PROGRAM
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS=	.20	.30	.40	.50	.60	.70	.80	.90	1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO UPPER GLEN RESERVOIR

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFUP	0	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	5.20	0.00	5.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	20.20	111.00	123.00	132.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	0.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 4.25 CP= .60 NTA= 0

RECESSION DATA
STRTQ= -1.70 QRCSN= -.10 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.23 HOURS, CP= .60 VOL= .99

7.	26.	53.	85.	121.	160.	201.	243.	287.	331.
371.	406.	434.	457.	473.	484.	487.	483.	466.	441.
416.	393.	371.	350.	330.	312.	294.	278.	262.	247.
233.	220.	208.	196.	185.	175.	165.	156.	147.	139.
131.	123.	117.	110.	104.	98.	92.	87.	82.	78.
73.	69.	65.	62.	58.	55.	52.	49.	46.	44.
41.	39.	37.	35.	33.	31.	29.	27.	26.	24.
23.	22.	21.	19.	18.	17.	16.	15.	15.	14.
13.	12.	12.	11.	10.	10.	9.	9.	8.	8.
7.	7.	6.	6.	6.	5.	5.	5.	5.	4.

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0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	21.33	20.13	1.20	269544.
										(542.)	(511.)	(30.)	(7632.64)

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM UPPER GLEN RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUTUP	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-526.	-1

STAGE	526.00	527.00	528.00	529.00	530.00	531.00	532.00	533.00	534.00	535.00
	535.50	536.00	537.00	538.00	539.00					
FLOW	0.00	117.00	330.00	606.00	933.00	1304.00	1714.00	2160.00	3140.00	3657.00
	4716.00	6441.00	8923.00	11531.00	14602.00					
SURFACE AREA=	0.	7.	9.							
CAPACITY=	0.	101.	212.							
ELEVATION=	481.	526.	540.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
526.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
533.0	0.0	0.0	0.

PEAK OUTFLOW IS 1468. AT TIME 20.00 HOURS

PEAK OUTFLOW IS 2211. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 2947. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 3687. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 4423. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 5160. AT TIME 19.75 HOURS

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PEAK OUTFLOW IS 5897. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 6635. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 7372. AT TIME 19.75 HOURS

SUB-AREA RUNOFF COMPUTATION

INFLOW TO LOWER RES LESS UPPER RES

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	INFLO	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.20	0.00	5.90	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	20.20	111.00	123.00	132.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	0.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 1.25 CP= .60 NTA= 0

RECESSION DATA

STRTQ= -1.70 QRCSN= -.10 RTIOR= 2.00

UNIT HYDROGRAPH 29 END-OF-PERIOD ORDINATES, LAG= 1.24 HOURS, CP= .60 VOL= 1.00

5.	18.	36.	52.	62.	62.	54.	43.	35.	28.
23.	19.	15.	12.	10.	8.	6.	5.	4.	3.
3.	2.	2.	1.	1.	1.	1.	1.	1.	

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	21.33	20.13	1.20	10752.
										(542.)	(511.)	(30.)	(304.46)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

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COMBINE HYDROGRAPHS

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	ADD	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

ROUTE OUTFLOW FROM [illegible] GIVEN RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUTLO	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-466.	-1

STAGE	466.00	467.00	468.00	469.00	470.00	470.50	471.00	472.00	473.00	474.00
	475.00	476.00	477.00	478.00	479.00	480.00	481.00			
FLOW	0.00	56.00	157.00	342.00	595.00	741.00	819.00	1173.00	1738.00	2469.00
	3399.00	4519.00	5835.00	7353.00	9078.00	11016.00	13173.00			
SURFACE AREA=	0.	5.	7.							
CAPACITY=	0.	64.	176.							
ELEVATION=	426.	466.	485.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
466.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
470.5	0.0	0.0	0.

PEAK OUTFLOW IS 1496. AT TIME 20.00 HOURS

PEAK OUTFLOW IS 2256. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 3010. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 3758. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 4521. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 5274. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 6027. AT TIME 19.50 HOURS

PEAK OUTFLOW IS 6779. AT TIME 19.75 HOURS

PEAK OUTFLOW IS 7532. AT TIME 19.75 HOURS

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OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	INFUP	5.20	1	1474.	2211.	2948.	3685.	4422.	5160.	5897.	6634.	7371.
		(13.47)		(41.74)(	62.61)(	83.49)(	104.36)(	125.23)(	146.10)(	166.97)(	187.84)(	208.72)
ROUTED TO	OUTUP	5.20	1	1468.	2211.	2947.	3687.	4423.	5160.	5897.	6635.	7372.
		(13.47)		(41.57)(	62.61)(	83.45)(	104.41)(	125.23)(	146.11)(	166.99)(	187.87)(	208.75)
HYDROGRAPH AT	INFLO	.20	1	114.	170.	227.	284.	341.	398.	454.	511.	568.
		(.52)		(3.22)(	4.83)(	6.43)(	8.04)(	9.65)(	11.26)(	12.87)(	14.48)(	16.09)
2 COMBINED	ADD	5.40	1	1498.	2257.	3009.	3764.	4520.	5278.	6030.	6783.	7536.
		(13.99)		(42.42)(	63.92)(	85.20)(	106.59)(	127.99)(	149.45)(	170.76)(	192.06)(	213.40)
ROUTED TO	OUTLO	5.40	1	1496.	2256.	3010.	3758.	4521.	5274.	6027.	6779.	7532.
		(13.99)		(42.36)(	63.88)(	85.22)(	106.41)(	128.02)(	149.33)(	170.68)(	191.95)(	213.29)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	526.00	526.00	533.00
STORAGE	101.	101.	152.
OUTFLOW	0.	0.	2160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	531.40	0.00	139.	1468.	0.00	20.00	0.00
.30	533.05	.05	152.	2211.	1.00	19.75	0.00
.40	533.80	.80	158.	2947.	4.25	19.75	0.00
.50	535.01	2.01	168.	3687.	6.00	19.75	0.00
.60	535.36	2.36	171.	4423.	7.25	19.75	0.00
.70	535.63	2.63	173.	5160.	8.50	19.75	0.00
.80	535.84	2.84	175.	5897.	9.25	19.75	0.00
.90	536.08	3.08	177.	6635.	10.00	19.75	0.00
1.00	536.38	3.38	180.	7372.	10.75	19.75	0.00

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	466.00	466.00	470.50
STORAGE	64.	64.	87.
OUTFLOW	0.	0.	741.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	472.57	2.07	98.	1496.	7.75	20.00	0.00
.30	473.71	3.21	104.	2256.	10.50	19.75	0.00
.40	474.58	4.08	109.	3010.	12.50	19.75	0.00
.50	475.32	4.82	114.	3758.	13.75	19.75	0.00
.60	476.00	5.50	118.	4521.	15.25	19.75	0.00
.70	476.57	6.07	121.	5274.	16.00	19.75	0.00
.80	477.13	6.63	124.	6027.	17.00	19.50	0.00
.90	477.62	7.12	127.	6779.	17.75	19.75	0.00
1.00	478.10	7.60	130.	7532.	18.50	19.75	0.00

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EOI ENCOUNTERED.

```
A3                    NEW ENGLAND DIVISION - CORPS OF ENGINEERS
B     300       0       10        0        0        0        0        0       -4        0
B1      5
J       2       1        1
J1  0.105
K       0   INFUP                                                    1
K1                    INFLOW TO UPPER GLEN RESERVOIR
M       1       1      5.2                 0                                  1
P       0    20.2      111      123      132
T                                                                    0     0.05
W    4.25     0.6
X    -1.7    -0.1        2
K       1   OUTUP                                                    1
K1                 ROUTED OUTFLOW FROM UPPER GLEN RESERVOIR
Y                                                    1        1
Y1      1                                                             -526       -1
Y4    526      527      528      529      530      531      532      533      534      535
Y4  535.5      536      537      538      539
Y5      0      117      330      606      933     1304     1714     2160     3140     3657
Y5   4716     6441     8923    11531    14602
$A      0      6.7      9.3
$E    485      526      540
$$    526
$D    533
K       1   CHANLD                                                   1
K1                 CHANNEL ROUTING TO LOWER GLEN RESERVOIR
Y                                                    1        1
Y1      1                                                               -1
Y6   0.08     0.04     0.08      466      500     1100      .02
YZ      0      500       10      490       90      480      120      420      160      466
Y7    258      499      259    499.5      260      500
K       1   GLENLD                                                   1
K1                 ROUTED OUTFLOW THROUGH LOWER GLEN RESERVOIR
Y                                                    1        1
Y1      1                                                             466       -1
Y1    466      467      468      469      470    470.5      471      472      173      474
Y4    475      476      477      478      479      480      481
Y5      0       56      157      342      595      741      819     1173     1738     2469
Y5   3399     4519     5835     7353     9078    11016    13173
$A      0      4.8      7.1
$E    439      466      485
$$    466
$D  470.5
U0     25     0.01      430      1.0      466    470.5
UB     25     0.01      430      1.0      466      475
K       1       1   DS-1                                                 1
K1                 CHANNEL ROUTING TO STREAM TRANSITION 1
Y                                                    1        1
Y1      1                                                               1
Y6   0.08     0.04     0.08      200      350     2000     0.05
Y7      0      150      120      315      160      320      360      320      430      300
Y7    510      286      530      300      650      350
K       1   DS-2
```

```
 56          K1          CHANNEL ROUTING TO STREAM TRANSITION 2
 57          Y                                   1       1
 58          Y1    1                                                 -1
 59          Y6  0.06    0.04    0.06     240     260    3600    .013
 60          Y7     0     260       1     259       2     259     500      250      850      240
 61          Y7  1300     250    1750     260    1751     261
 62          K      1  GREEN                                         1
 63          K1          ROUTED OUTFLOW THROUGH GREENFIELD RD CULVERT
 64          Y                                   1       1
 65          Y1    1                                                 -1       -1
 66          Y4   237     238     239     240     241     242     243      244      245      246
 67          Y4   247     248     249     250     251     252
 68          Y5     0     125     324     529     714     868     983     1060     1096     1113
 69          Y5  1159    1269    1371    3946    9622   18391
 70          $A     0    10.4    19.1
 71          $E   237     249     255
 72          $$ 237.1
 73          $D   249
 74          K      1  HAZARD                                        1
 75          K1          CHANNEL ROUTING TO HAZARD CENTER
 76          Y                                   1       1
 77          Y1    1                                                 -1
 78          Y6  0.05    0.04    0.05     227     240    1400     .01
 79          Y7     0     240     135     235     755     230    1045      229     1055      227
 80          Y7  1065     229    1615     235    1665     240
 81          K     99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

```
                    RUNOFF HYDROGRAPH AT      INFLOW
                    ROUTE HYDROGRAPH TO       OUTFLOW
                    ROUTE HYDROGRAPH TO       CHANLO
                    ROUTE HYDROGRAPH TO       GLENLO
                    ROUTE HYDROGRAPH TO       DS-1
                    ROUTE HYDROGRAPH TO       DS-2
                    ROUTE HYDROGRAPH TO       GREEN
                    ROUTE HYDROGRAPH TO       HAZARD
                    END OF NETWORK
```

HYDROLOGIC ANALYSIS OF LOWER GLEN RESERVOIR DAM BREACH
NATIONAL DAM INSPECTION PROGRAM
NEW ENGLAND DIVISION - CORPS OF ENGINEERS

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
500	0	10	0	0	0	0	0	4	0

JOPER	NWT	LROPT	TRACE
0	0	0	0

MULTI PLAN ANALYSES TO BE PERFORMED
NPLAN= 2 NRTIO= 1 LRTIO= 1

HYDROGRAPH DATA

IHYD	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISAME	ISTAT	IECON
1	1	5.20	0.00	5.20	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	20.20	111.00	123.00	132.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	0.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TP= 4.25 CP= .60 NTA= 0

RECESSION DATA

STRTQ= -1.70 QRCSN= .10 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 4.25 HOURS, CP= .60 VOL= .96

4.	14.	30.	48.	69.	92.	116.	142.	169.	197.
225.	255.	284.	315.	344.	371.	395.	416.	435.	451.
465.	476.	484.	489.	491.	489.	483.	470.	452.	435.
419.	403.	387.	373.	359.	345.	332.	319.	307.	295.
284.	273.	263.	253.	243.	234.	225.	217.	208.	201.
193.	186.	179.	172.	165.	159.	153.	147.	142.	136.
131.	126.	121.	117.	112.	108.	104.	100.	96.	92.
89.	86.	82.	79.	76.	73.	70.	68.	65.	63.
60.	58.	56.	54.	52.	50.	48.	46.	44.	43.
41.	39.	38.	36.	35.	34.	32.	31.	30.	29.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
						0							
									SUM	21.33	20.13	1.20	393600.
										(542.)	(511.)	(30.)	(11145.51)

HYDROGRAPH ROUTING

ROUTED OUTFLOW FROM UPPER GLEN RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
OUTUP	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

RLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-526.	-1

STAGE	526.00	527.00	528.00	529.00	530.00	531.00	532.00	533.00	534.00	535.00
	535.50	536.00	537.00	538.00	539.00					
FLOW	0.00	117.00	330.00	606.00	933.00	1304.00	1714.00	2160.00	3140.00	3652.00
	4716.00	6441.00	8923.00	11531.00	14602.00					
SURFACE AREA=	0.	7.	9.							
CAPACITY=	0.	72.	203.							
ELEVATION=	485.	526.	540.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
526.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PEAK OUTFLOW IS 773. AT TIME 19.83 HOURS

DAM DATA

TOPEL	COOD	EXPD	DAMWID
533.0	0.0	0.0	0.

PEAK OUTFLOW IS 773. AT TIME 19.83 HOURS

CHANNEL ROUTING - LOWER GLEN RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
CHANLO	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	466.0	500.0	1100.	.02000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

	0.00	500.00	10.00	490.00	90.00	480.00	120.00	470.00	160.00	466.00	
	258.00	499.00	259.00	499.50	260.00	500.00					
STORAGE	0.00	.52	2.10	4.55	7.51	10.95	14.87	19.27	24.16	29.80	
	36.33	43.75	52.05	61.24	71.22	81.57	92.24	103.23	114.54	126.16	
OUTFLOW	0.00	100.47	637.97	1949.48	4009.33	6825.67	10452.72	14948.50	20482.78	27529.74	
	35664.83	44969.33	55516.44	67375.49	80781.88	95672.68	111906.09	129475.97	148382.41	170316.87	
STAGE	466.00	467.77	469.58	471.37	473.16	474.95	476.74	478.53	480.32	482.11	
	483.89	485.68	487.47	489.26	491.05	492.84	494.63	496.42	498.21	500.00	
FLOW	0.00	100.47	637.97	1949.48	4009.33	6825.67	10452.72	14948.50	20482.78	27529.74	
	35664.83	44969.33	55516.44	67375.49	80781.88	95672.68	111906.09	129475.97	148382.41	170316.87	

MAXIMUM STAGE IS 469.8

MAXIMUM STAGE IS 469.8

HYDROGRAPH ROUTING

ROUTED OUTFLOW THROUGH LOWER GLEN RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
GLENLO	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-466.	-1

STAGE	466.00	467.00	468.00	469.00	470.00	470.50	471.00	472.00	473.00	474.00
	475.00	476.00	477.00	478.00	479.00	480.00	481.00			
FLOW	0.00	56.00	157.00	342.00	595.00	741.00	919.00	1173.00	1730.00	2462.00
	3377.00	4519.00	5835.00	7353.00	9078.00	11016.00	13173.00			
SURFACE AREA=	0.	7.	7.							
CAPACITY=	0.	50.	170.							
ELEV =	430.	466.	485.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
466.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
470.5	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
25.	.01	430.00	1.00	466.00	470.50

BEGIN DAM FAILURE AT 19.50 HOURS

PEAK OUTFLOW IS 3054. AT TIME 20.15 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
25.	.01	430.00	1.00	466.00	475.00

PEAK OUTFLOW IS 766. AT TIME 20.17 HOURS

HYDROGRAPH ROUTING

CHANNEL ROUTING TO STREAM TRANSITION 1

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRI	INAME	ISTAGE	IAUTO
DS-1	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0800	.0400	.0800	288.0	350.0	2800.	.05000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 350.00 120.00 315.00 160.00 320.00 360.00 320.00 430.00 300.00
510.00 288.00 530.00 300.00 650.00 350.00

STORAGE	0.00	2.85	11.41	25.67	45.54	69.84	98.18	130.55	166.96	209.47
	221.52	373.95	480.37	590.78	705.18	823.56	945.94	1072.31	1202.66	1337.01
OUTFLOW	0.00	452.94	2875.97	8479.32	18568.95	33998.54	54349.36	79954.62	111166.51	148488.84
	130240.97	215554.21	319170.19	440055.53	577524.11	731091.97	900405.99	1085203.73	1285298.62	1500513.67
STAGE	288.00	291.26	294.53	297.79	301.05	304.32	307.58	310.84	314.11	317.37
	320.63	323.89	327.16	330.42	333.68	336.95	340.21	343.47	346.74	350.00
FLOW	0.00	452.94	2875.97	8479.32	18568.95	33998.54	54349.36	79954.62	111166.51	148488.84
	130240.97	215554.21	319170.19	440055.53	577524.11	731091.97	900405.99	1085203.73	1285298.62	1500513.67

MAXIMUM STAGE IS 294.5

MAXIMUM STAGE IS 291.7

	ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	DS-2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
	0.0	0.000	0.00	1	1	0	0	0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	240.0	260.0	3600.	.01300

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 260.00 1.00 259.00 2.00 259.00 500.00 250.00 850.00 240.00
1300.00 250.00 1750.00 260.00 1751.00 261.00

STORAGE	0.00	3.66	14.65	32.97	58.61	91.57	131.87	179.48	234.43	296.70
	366.52	445.31	533.28	630.44	736.78	852.32	977.04	1110.95	1254.05	1404.17
OUTFLOW	0.00	122.68	778.99	2296.71	4946.25	8968.16	14583.21	21997.73	31406.76	42996.17
	57470.67	74971.45	95170.20	118259.46	144419.09	173821.01	206631.23	243010.97	283117.33	334822.01
STAGE	240.00	241.05	242.11	243.16	244.21	245.26	246.32	247.37	248.42	249.47
	250.53	251.58	252.63	253.68	254.74	255.79	256.84	257.89	258.95	260.00
FLOW	0.00	122.68	778.99	2296.71	4946.25	8968.16	14583.21	21997.73	31406.76	42996.17
	57470.67	74971.45	95170.20	118259.46	144419.09	173821.01	206631.23	243010.97	283117.33	334822.01

MAXIMUM STAGE IS 243.2

HYDROGRAPH ROUTING

MAXIMUM STAGE IS 242.1

ROUTED OUTFLOW THROUGH GREENFIELD RD CULVERT

	ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	GREEN	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
	0.0	0.000	0.00	1	1	0	0	0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	-1

STAGE	237.00	238.00	239.00	240.00	241.00	242.00	243.00	244.00	245.00	246.00
	247.00	248.00	249.00	250.00	251.00	252.00				
FLOW	0.00	125.00	324.00	529.00	714.00	868.00	983.00	1060.00	1096.00	1113.00
	1159.00	1269.00	1371.00	3946.00	9622.00	18391.00				
SURFACE AREA=	0.	10.	19.							
CAPACITY=	0.	42.	129.							
ELEVATION=	237.	249.	255.							

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
237.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
249.0	0.0	0.0	0.

PEAK OUTFLOW IS 1027. AT TIME 20.50 HOURS

CHANNEL ROUTED TO HAZARD CE...

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
	HAZARD	1	0	0	0	0	1	0	0

ALL ELANS HAVE SAME ROUTING DATA

	QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
	0.0	0.000	0.00	1	1	0	0	0

	NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
	1	0	0	0.000	0.000	0.000	-1.	0

NORMAL DEPTH CHANNEL ROUTING

	QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
	.0500	.0400	.0500	227.0	240.0	1400.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC
0.00 240.00 135.00 235.00 755.00 230.00 1045.00 229.00 1055.00 227.00
1065.00 229.00 1615.00 235.00 1665.00 240.00

STORAGE	0.00	.08	.30	.69	4.45	13.47	25.92	41.62	60.56	82.75
	108.18	136.85	168.65	201.64	235.20	269.30	303.97	339.19	374.97	411.31
OUTFLOW	0.00	4.21	26.73	56.99	298.91	1419.45	3577.78	6792.33	11167.68	16809.31
	23820.99	32304.03	42753.98	55671.82	70087.46	85948.25	103213.63	121851.56	141836.44	163147.61
STAGE	227.00	227.68	228.37	229.05	229.74	230.42	231.11	231.79	232.47	233.16
	233.84	234.53	235.21	235.89	236.58	237.26	237.95	238.63	239.32	240.00
FLOW	0.00	4.21	26.73	56.99	298.91	1419.45	3577.78	6792.33	11167.68	16809.31
	23820.99	32304.03	42753.98	55671.82	70087.46	85948.25	103213.63	121851.56	141836.44	163147.61

MAXIMUM STAGE IS 230.5

MAXIMUM STAGE IS 230.0

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO	RATIOS APPLIED TO FLOWS
				1	.11
HYDROGRAPH AT	INFLOW	5.20 (13.47)	1		777. (22.01)(
			2		777. (22.01)(
ROUTED TO	OUTFLOW	5.20 (13.47)	1		773. (21.89)(
			2		773. (21.89)(

ROUTED TO	CHANLO	5.20 (13.47)	1	773. (21.88)(
			2	773. (21.88)(
ROUTED TO	GLENLO	5.20 (13.47)	1	3032. (85.84)(
			2	766. (21.68)(
ROUTED TO	DS-1	5.20 (13.47)	1	2914. (82.53)(
			2	766. (21.69)(
ROUTED TO	DS-2	5.20 (13.47)	1	2507. (70.98)(
			2	764. (21.64)(
ROUTED TO	GREEN	5.20 (13.47)	1	1827. (51.73)(
			2	763. (21.61)(
ROUTED TO	HAZARD	5.20 (13.47)	1	1602. (45.35)(
			2	763. (21.61)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	526.00	526.00	533.00
STORAGE	92.	92.	143.
OUTFLOW	0.	0.	2160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	529.51	0.00	116.	773.	0.00	19.83	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	526.00	526.00	533.00
STORAGE	92.	92.	143.
OUTFLOW	0.	0.	2160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	529.51						

PLAN 1 STATION CHANLO

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	773.	469.8	19.83

PLAN 2 STATION CHANLO

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
0.11	773	469.8	19.83

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	466.00	466.00	470.50
STORAGE	58.	58.	80.
OUTFLOW	0.	0.	741.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	470.54	.04	81.	3054.	.29	20.15	19.50

PLAN 2

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	466.00	466.00	470.50
STORAGE	58.	58.	80.
OUTFLOW	0.	0.	741.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	470.66	.16	81.	766.	1.50	20.17	0.00

PLAN 1 STATION DS-1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	2914.	294.5	20.17

PLAN 2 STATION DS-1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	766.	291.7	20.33

PLAN 1 STATION DS-2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	2507.	243.2	20.33

PLAN 2 STATION DS-2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	766.	242.1	20.50

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	237.00	237.10	249.00
STORAGE	0.	0.	42.
OUTFLOW	0.	13.	1371.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	249.18	.18	43.	1822.	.17	20.50	0.00

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	237.00	237.10	249.00
STORAGE	0.	0.	42.
OUTFLOW	0.	13.	1371.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.11	241.32	0.00	2.	763.	0.00	20.67	0.00

PLAN 1 STATION HAZARD

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	1602.	230.5	20.67

PLAN 2 STATION HAZARD

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.11	763.	230.2	20.67

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
MA	48	NED	MA	011	01				LOWER GLEN RESERVOIR DAM	4239.4	7236.7	05MAR81

POPULAR NAME	NAME OF IMPOUNDMENT
GREENFIELD DAM LOWER	LOWER GLEN (GREENFIELD) RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	06	GLEN BROOK	GREENFIELD	4	18000

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
PG	1904	S	46	46	87	64	NED	N	N	N	N	

REMARKS
INSP RES DRAIN SYS ,SPURTING SEEPAGE,BULGE DNSTR FACE DAM

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
?	95	U	41	740	1000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
TOWN OF GREENFIELD	CHARLES J DAY	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	MA DEQE	MA DEQE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
O'BRIEN & GERE ENGINEERS	03DEC80	PL92-367

REMARKS
32-2 SPILLWAYS 21',20'WIDE HT4.5',2.5'